

S Ambient air
628.161 monitoring report,
M26Lraa Livingston
1991 Railyard

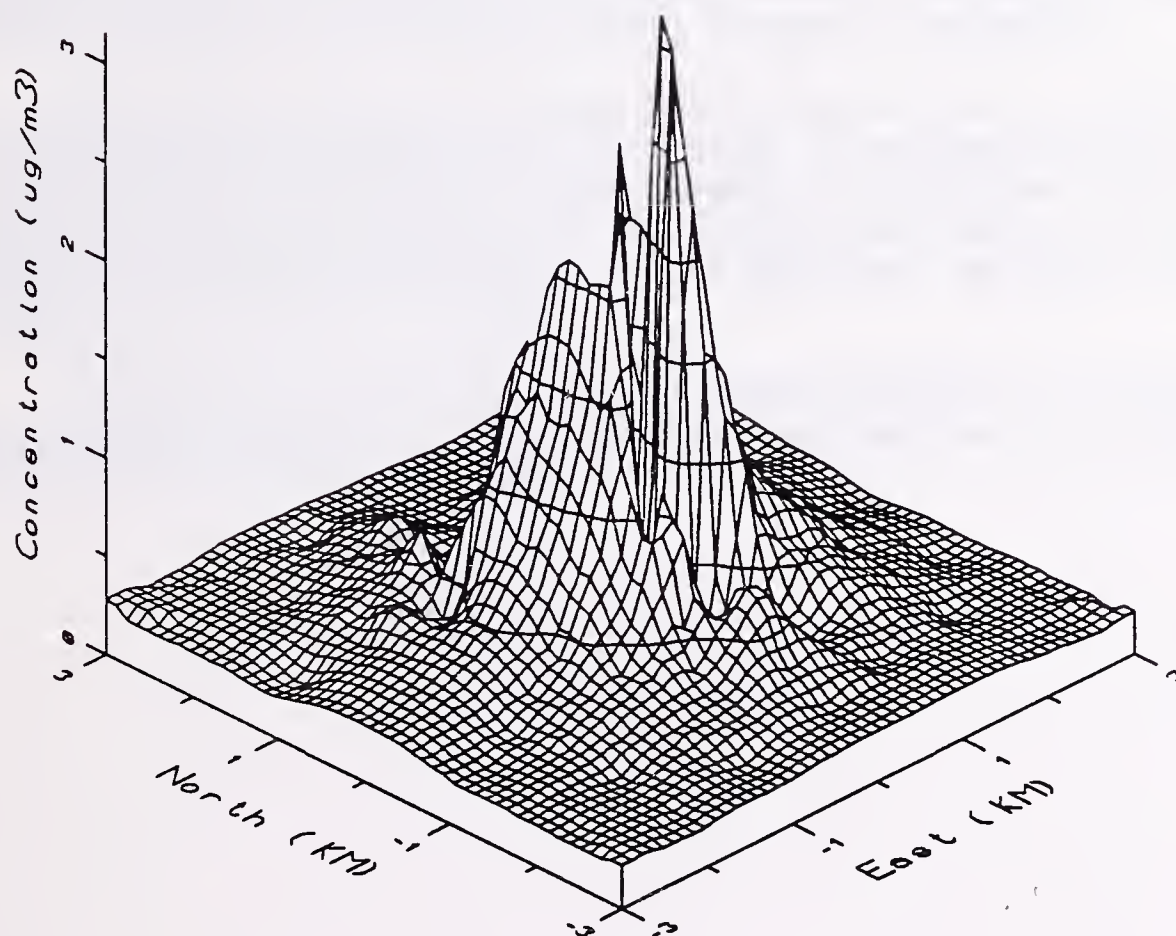
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Ambient Air Monitoring Report

Livingston Railyard



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Introduction

This document represents the results of ambient monitoring investigations conducted in Livingston, Montana. The report will be submitted to the Montana Department of Health and Environmental Sciences on a quarterly basis until the monitoring program has been completed. The report is being submitted in a 3-ring binder to allow for future quarterly reports. This will provide the reader with a complete document which will contain the results of all monitoring studies including quality control and quality assurance investigations.

Envirocon Inc has overall responsibility for the network. Envirocon purchased and currently operates the network on a daily basis. Bison Engineering Inc provides assistance with the network by conducting audits, coordinating a portion of the laboratory work, and finally by preparing all quarterly reports. Energy Labs, Billings, conducted all analyses for polynuclear aromatic hydrocarbons. NEA Laboratories, Beaverton, OR, conducted the elemental analysis of the PM10 filters.

The network's design and operation is being conducted in accordance with Section 14.4 of the Interim Remedial Measures Work Plan as specified by the Montana Department of Health and Environmental Sciences.



CERTIFICATION OF DATA INTEGRITY

Bison Engineering Inc. certifies that the data contained herein are, to the best of our knowledge, an accurate summary of air quality and meteorological conditions measured at the Livingston Railyard in Livingston, MT. Every effort was made to obtain accurate and representative data and to comply with procedures set forth in the Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II, Ambient Air Specific Methods (EPA-600/4-77-027a) and the conditions of Section 14.4 of the Interim Remedial Measures Work Plan (work plan) as required by the Montana Department of Health and Environmental Sciences.

Project Manager: Harold W. Roll

Title: Vice President

Date: February 28, 1991



1.0 NETWORK CONFIGURATION

1.1 Monitoring Locations - General

An ambient air quality network has been established near the Livingston Railroad to ascertain both the background air quality concentrations and the air quality values downwind of a number of clean-up activities. The requirements of the ambient network are contained in Section 14.4 of the Interim Remedial Measures Work Plan (work plan). The primary network consists of two distinct stations. Each station contains a PM10 air monitoring instrument. The second station (downwind site) also contains meteorological equipment, a total suspended particulate (TSP) instrument, and a PUF sampler which is designed to measure polynuclear aromatic hydrocarbons (PNA).

The monitoring sites and parameters to be measured were chosen with the department. The first site's primary purpose is to determine the ambient air quality upwind of all remedial activities. The downwind site was chosen as a worst-case example of downwind activity. A map is included with this report which locates the various monitoring sites. The coordinate location of these sites are shown below:



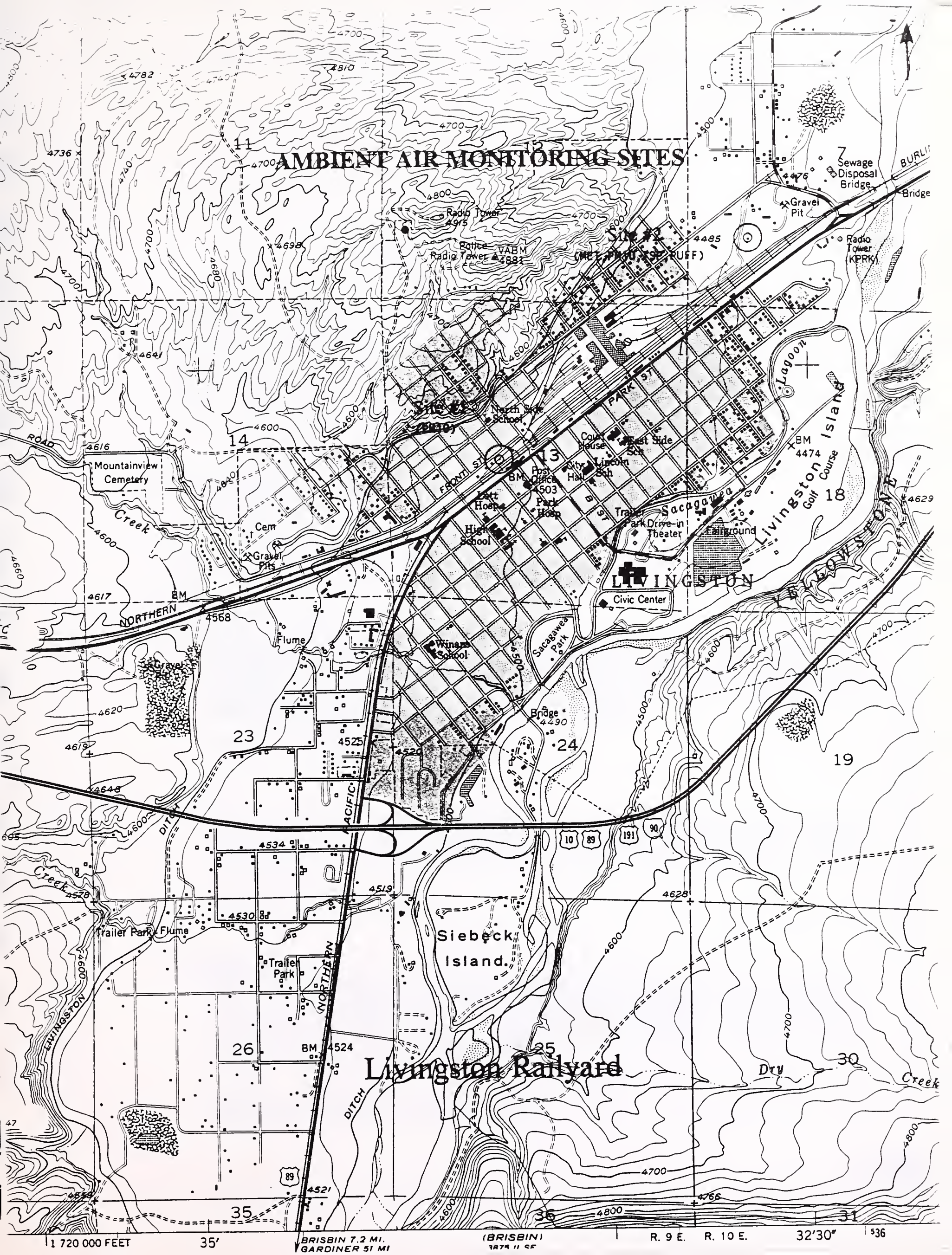


Table 1
Ambient Monitoring Locations

Site #	UTM East	UTM North	Latitude	Longitude
1	334050	5056410	45° 38' 36"	113° 7' 46"
2	335360	5057520	45° 39' 13"	113° 6' 47"

UTM Zone = 12

1.2 Monitoring Parameters

The monitoring network has been designed to collect several air pollutants. The following is a list of these parameters and the methodology used for analysis.

PM10

PM10 is a term that indicates particulate matter less than 10 microns in diameter. This parameter is commonly measured throughout the nation and represents the Montana and EPA methods for determining particulate matter in the atmosphere as it relates to ambient air quality standards. Both the upwind (site #1) and downwind (site #2) sites were designed to collect this information.

Method: 40 CFR Part 50, Appendix J

Metals

The PM10 collected material (filter) may be analyzed for concentrations of various metals. The method of analysis is X-Ray Fluorescence which provides a scan of 34 elements.

Method: X-Ray Fluorescence

Total Particulates

While PM10 provides a health basis comparison for human exposure to particulates, it does not include all particulates that may be suspended in the atmosphere. A high volume sampler (hi-vol) is used for this collection. The data may be compared to an earlier air quality standard for this pollutant. That standard was changed in 1987 to a PM10 methodology.

Method: Sections 1.11.1, 2.1.1, and 2.1.1.1, Montana Air Quality Bureau Quality Assurance Manual



Polynuclear Aromatic Hydrocarbons

Polynuclear aromatic hydrocarbons (PNAs) are a class of compounds that contain a benzene ring. This class of compounds was measured using a combination of filter collection (for PNAs which may be in a particulate form or associated with particulate) and a polyurethane foam (PUF) cartridge. The samples were collected and forwarded to Energy Laboratories Inc. for analysis.

Method: TO13 "Compendium of Methods for Determination of Toxic Organic Compounds in Ambient Air," Atmospheric and Exposure Assessment Laboratory, EPA, EPA/600/4-89/017, June, 1988.

Meteorology

A meteorological tower was set up at the downwind site in order to assess what meteorological events may lead to increasing or decreasing ambient air pollutants. The stations collected wind speed, wind direction, temperature, and wind sigma (standard deviation of the wind direction).

Method: Anemometer cup, wind vane, thermocouple, and computer data acquisition system. "Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD), Section 6, EPA, EPA-450/4-87-007.

1.3 Monitoring Frequency

The monitoring frequency for each parameter is provided below.



Table 2
Ambient Monitoring Frequency

PM10	One-day-in-six. 24-hour sample. Site #1 and Site #2.
TSP	One-day-in-six. 24-hour sample. Site #2 only.
Metals	6 PM10 samples from Site #1. 6 PM10 samples from Site #2. Samples periods to coincide.
PNA	Same schedule as PM10. Cease sampling after 6 weeks. Site #2 only.
Meteorology	Continuous sampling. Hourly data analysis. Site #2 only.



2.0 DATA SUMMARY

2.1 PM10

A PM10 network has been established to coincide with the sites noted above. The PM10 network consists of one monitor upwind of the remedial activities (site #1) and one monitor downwind (site #2).

The data collection for the network began on November 10, 1990. Data for this reporting period (through December 31) includes 9 samples collected at each site. The mean PM10 values for site #1 was 16 $\mu\text{g}/\text{m}^3$ and 14 $\mu\text{g}/\text{m}^3$ for site #2. The peak reporting value for the network was 25. These values are compared against the Montana ambient air quality standards below.

Table 3
PM10 Results vs Ambient Standards

	Standard	Site #1	Site #2
Mean	50*	16	14
Peak	150**	25	18

Units: $\mu\text{g}/\text{m}^3$
 * Annual mean
 ** Not to be exceeded more than once per year.

A complete listing of the PM10 data and various summary statistics are provided in Appendix A of this report. The statistics include monthly means, yearly mean-to-date, geometric mean and standard deviation, etc. Appendix B contains the results of calibrations, audits, precision checks, etc.



2.2 Total Suspended Particulate

The total suspended particulate network included the operation of one sampler at Site #2. The frequency of operation is the same as PM10.

The data collection for the network began on November 17, 1990. Data for this reporting period (through December 31) includes 6 samples. The mean TSP value was $29 \mu\text{g}/\text{m}^3$ and the peak value was $44 \mu\text{g}/\text{m}^3$. These values are compared against the old Montana ambient air quality standards below.

Table 4
TSP Results vs Old Ambient Standards

	Standard	Site #2
Mean	75*	29
Peak	260**	44

Units: $\mu\text{g}/\text{m}^3$

* Annual mean

** Not to be exceeded more than once per year.

A complete listing of the TSP data and various summary statistics are provided in Appendix A of this report. The statistics include monthly means, yearly mean-to-date, geometric mean and standard deviation, etc. Appendix B provides the necessary quality control information including calibration and auditing results.

2.3 Polynuclear Aromatic Hydrocarbons

The PUF sampler, designed to collect PNA material, was located at site #2. The sampler began data collection on November 10, 1990 and ceased operation on



December 14, 1990. A total of 6 samples were collected in addition to a blank sample.

Unlike PM10 and TSP, there are no specific standards for comparison. The analysis consisted of determining the concentration of 13 specific compounds on both the collected filter and the polyurethane foam. A summary of the air concentration results ($\mu\text{g}/\text{m}^3$) for each run day is contained in Appendix A. A complete listing of the laboratory investigations are found in Appendix C. Quality control information for this and all other sampling results are found in Appendix B. Finally, the table below provides the mean concentration of each compound collected for the 6 run days.



Table 5
Mean PNA Concentrations
Livingston, MT

Compound	Concentration ($\mu\text{g}/\text{m}^3$)
Acenaphthene	0.0039
Acenaphylene	0.0033
Anthracene	<0.0034
Benzo(a)anthracene	<0.0032
Benzo(a)pyrene	<0.0032
Benzo(b)fluoranthene	0.0037
Benzo(ghi)perylene	<0.0032
Benzo(k)fluoranthene	<0.0032
Chrysene	0.0032
Dibenzo(a,h)anthracene	<0.0032
Fluoranthene	0.0052
Fluorene	0.0076
Ideno(1,2,3-cd)pyrene	<0.0032
Napthalene	0.0052
Phenanthrene	0.0193
Pyrene	<0.0044



2.4 Metals

The PM10 filter media was analyzed for metal concentrations. A total of 6 sample days were collected. Both the upwind and downwind samples were subject to this analysis. With the exception of lead, none of these elements are associated with an ambient air quality standard for comparison. The highest single value observed for lead was $0.26 \mu\text{g}/\text{m}^3$. The ambient air quality standard is $1.5 \mu\text{g}/\text{m}^3$ averaged over 3 months. The average for all 6 samples for the downwind site was $.07 \mu\text{g}/\text{m}^3$ and $.005 \mu\text{g}/\text{m}^3$ for the upwind site.

A summary of the air concentration results for each run day ($\mu\text{g}/\text{m}^3$) is contained in Appendix A. The tables compare the upwind and downwind concentration for each element. A complete listing of the laboratory investigations are found in Appendix C. Quality control information for this and all other sampling results are found in Appendix B. The table below provides a summary of the mean values found for each element at both the upwind and downwind sites.



Table 6
Mean Elemental Results

Livingston, MT

Element	Upwind ($\mu\text{g}/\text{m}^3$)	Downwind ($\mu\text{g}/\text{m}^3$)
Aluminum	0.0000	0.0000
Phosphorus	0.0000	0.0000
Sulfur	0.1297	0.0423
Chlorine	0.0000	0.1740
Potassium	0.3892	0.4187
Calcium	1.3810	1.2225
Titanium	0.0500	0.0460
Vanadium	0.0012	0.0016
Chromium	0.0003	0.0000
Manganese	0.0066	0.0035
Iron	0.4060	0.1613
Nickel	0.0000	0.0000
Copper	0.0039	0.0041
Zinc	0.0000	0.0889
Gallium	0.0000	0.0000
Germanium	0.0007	0.0009
Arsenic	0.0014	0.0057
Selenium	0.0006	0.0000
Bromine	0.0026	0.0128
Rubidium	0.0032	0.0036
Strontium	0.0136	0.0126
Yttrium	0.0028	0.0016
Zirconium	0.0178	0.0173
Molybdenum	0.1063	0.1057
Palladium	0.0154	0.0029
Silver	0.0096	0.0041
Cadmium	0.0084	0.0236
Indium	0.0155	0.0128
Tin	0.0180	0.0219
Antimony	0.0207	0.0202
Barium	0.0096	0.0151
Lanthanum	0.1877	0.0857
Mercury	0.0000	0.0000
Lead	0.0050	0.0699



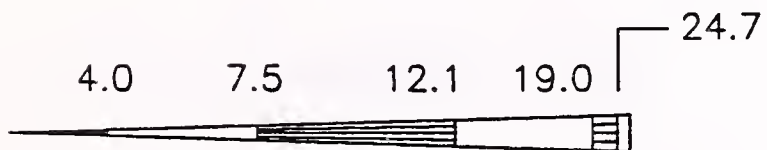
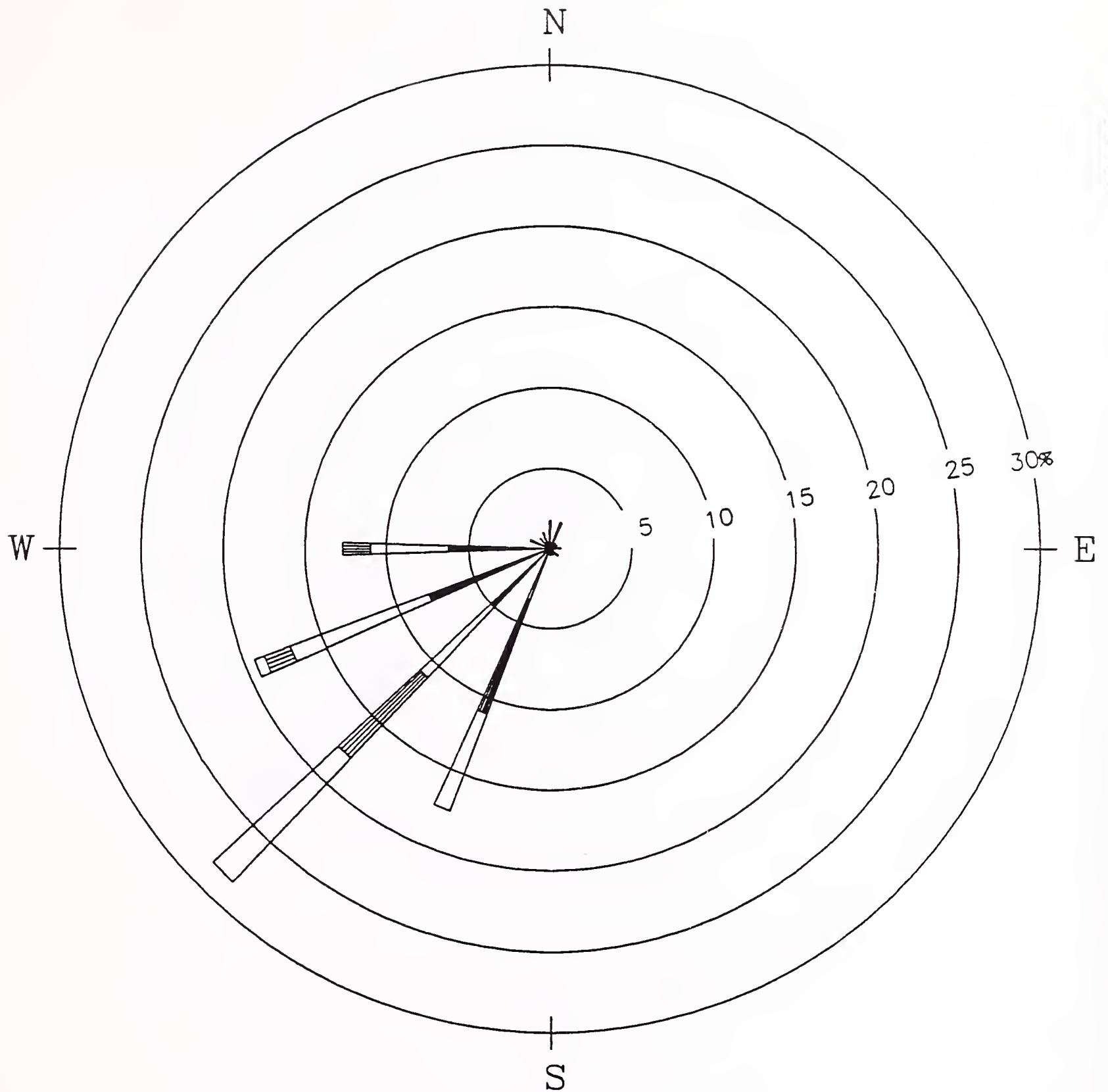
2.5 Meteorology

The network also required the establishment of a meteorological station (site #2). The meteorological equipment is manufactured by Met One and measures wind speed, wind direction, temperature, and wind sigma. Overall data recovery for the meteorological system was excellent. Only the last few days of the year are missing due to a corrupted data file. An attempt is being made to recover this data. If the attempt is successful, the data will be amended to the existing files and processed in the next quarterly report.

During this report period (November 11 through December 31) the average wind speed was 18 miles per hour, the resultant wind direction was 228 degrees, and the percentage of calm hours was 0.0%. The maximum temperature for the period was 66 °F, the minimum temperature was -24 °F, and the average temperature was 30 °F.

Appendix A contains a complete listing of the meteorological information for wind speed, direction, temperature, and sigma. In addition, wind frequency distributions are provided on a monthly and seasonal (to-date) basis. Finally, the appropriate wind roses (Figures 1 - 3) are provided below to give a graphical perspective of the results.





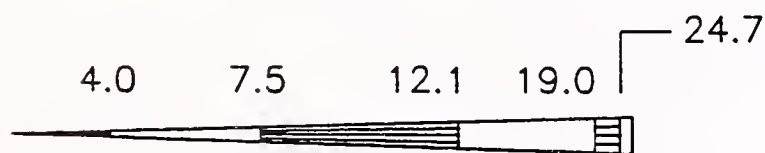
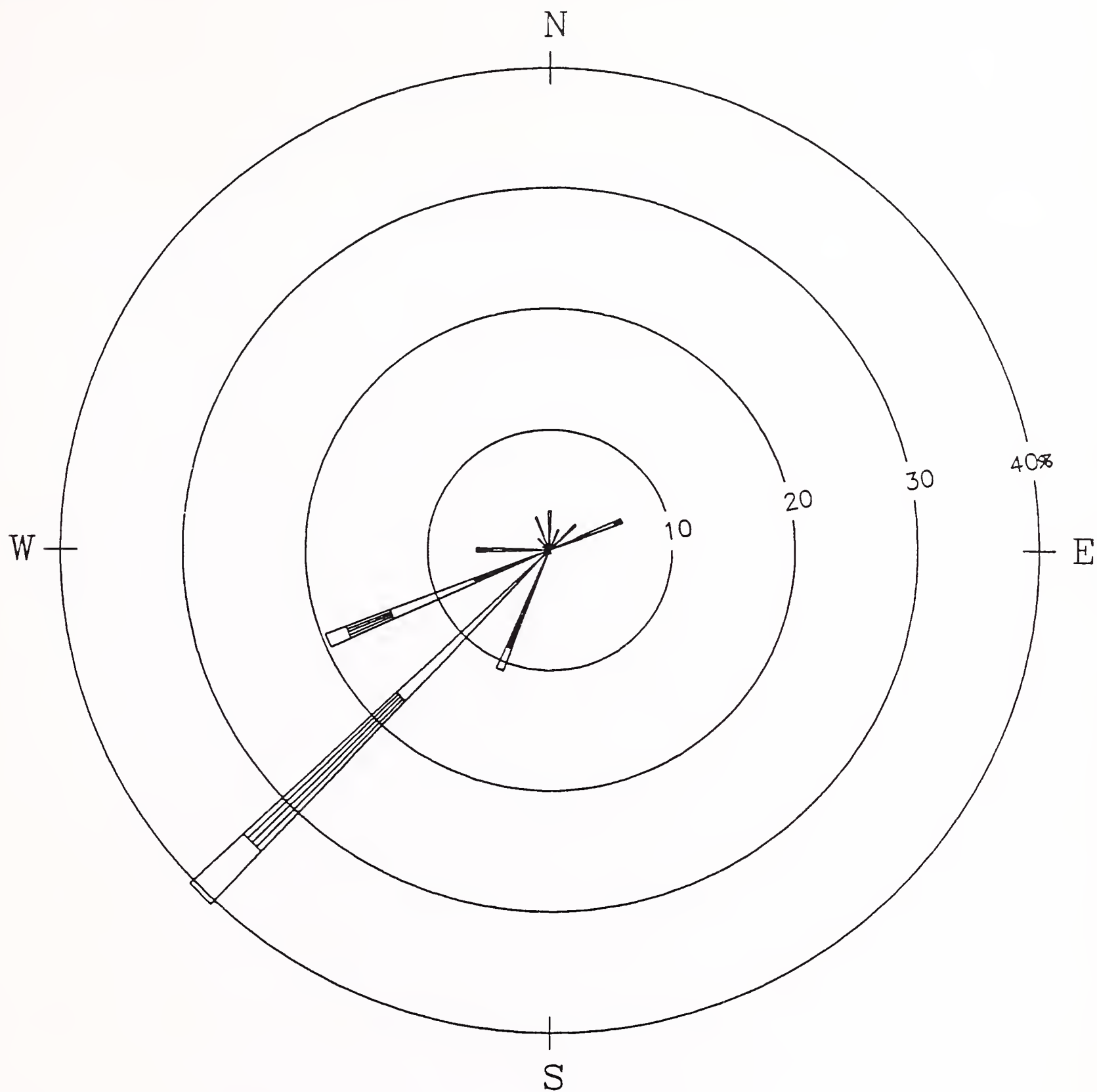
Wind Speed Class Boundaries
(Miles/Hour)

NOTES:

Diagram of the Frequency of
Occurrence for each Wind Direction.
Wind Direction is the Direction
From Which the Wind is Blowing.

WINDROSE

Livingston – Downwind
PERIOD: Nov. 1990



Wind Speed Class Boundaries
(Miles/Hour)

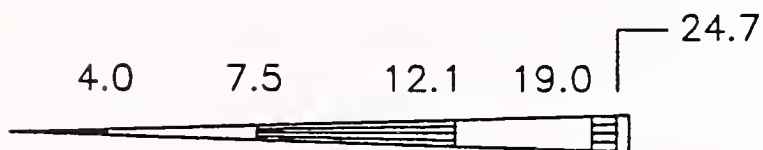
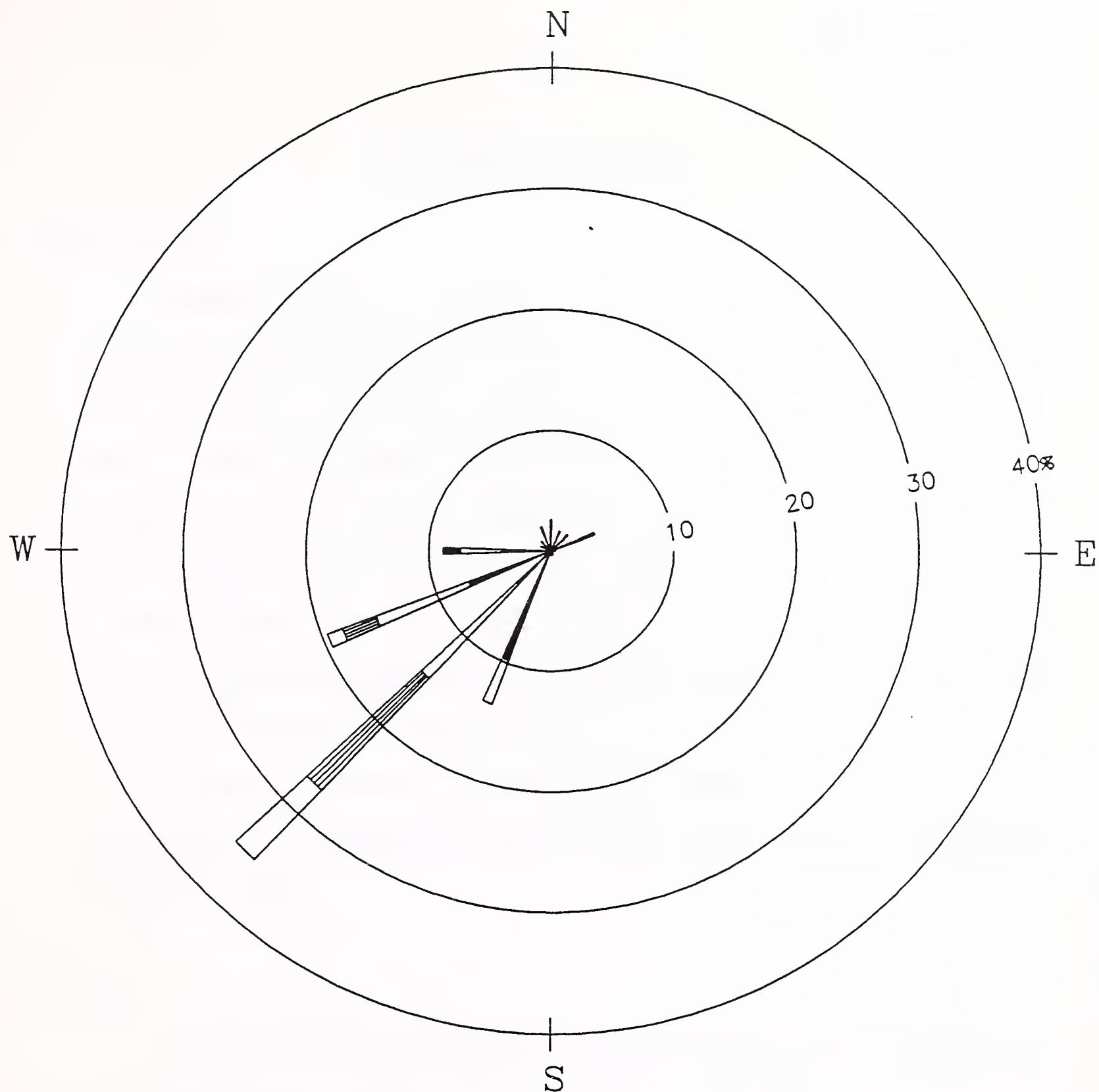
NOTES:
Diagram of the Frequency of
Occurrence for each Wind Direction.
Wind Direction is the Direction
From Which the Wind is Blowing.

WINDROSE

Livingston – Downwind
PERIOD: Dec. 1990

Bison
Engineering





Wind Speed Class Boundaries
(Miles/Hour)

NOTES:

Diagram of the Frequency of
Occurrence for each Wind Direction.
Wind Direction is the Direction
From Which the Wind is Blowing.

WINDROSE

Livingston — Downwind
4th Quarter — 1990

Bison
Engineering



3.0 DATA ANALYSIS

3.1 Introduction

The primary purpose of the ambient monitoring network is to assess any impact that the work plan may be having on ambient air quality. The first step in the assessment is to measure any appropriate parameters which could be reasonably expected to enter the ambient atmosphere as a result of the work plan. These parameters, defined by Section 14.4 of the work plan, included PM10, TSP, PNA, and metals. The second step of the assessment is to compare these results with previously established ambient air quality standards, where applicable. The final step is to compare the results with a nearby monitoring site (when available) to determine potential concentrations for activities which are not influenced by the work plan.

It is not the subject of this report to provide a complete investigation for each of these activities. It is appropriate, however, to assess some of the initial characteristics of the results to date.

3.2 PM10

Section 2 of this report provided a comparison between the collected PM10 values and the Montana and federal ambient air quality standards. The results indicate values far below these levels of concern. Data to date indicates no threat of an exceedance of these standards.

It is interesting to compare the upwind and downwind monitoring results. A comparison was made between the two data sets and the results of this investigation is provided below.



Table 7
Upwind/Downwind Comparison
PM10

Livingston, MT

Sample Date	Upwind	Downwind	Difference
11/10/90	11	10	-1
11/19/90	20	13	-7
11/25/90	18	18	0
12/ 1/90	18	12	-6
12/ 7/90	11	12	1
12/14/90	10	18	8
12/19/90	25	10	-15
12/25/90	14	14	0
12/31/90	13	16	3

Units: Micrograms/cubic meter

Two statistical tests were applied to the data. The tests (paired and unpaired t-test) were designed to assess whether or not there is enough evidence to reject the null hypothesis that the two means are the same. The results of these tests are summarized below.



Summary Statistics:

Upwind:	Mean:	15.6
	Std Dev:	5.03
	# of Samples:	9
Downwind:	Mean:	13.7
	Std Dev:	3.08
	# of Samples:	9
Difference:	Mean:	-1.89
	Std Dev:	6.64
	# of Samples:	9

Comparison of Upwind and Downwind Means

Paired Difference t-test.

$t = \frac{\text{Mean}}{S/(n)^{\frac{1}{2}}}$ <p>S = standard deviation</p> <p>t = - 0.85</p> <p>Critical t (95%) = 2.31</p>
--

Unpaired t-test.

$t = \frac{\text{Mean1} - \text{Mean2}}{S(1/n + 1/n)^{\frac{1}{2}}}$ <p>S = pooled standard deviation = 4.17</p> <p>t = - 0.97</p> <p>Critical t (95%) = 2.12</p>

Since the "critical" t value falls within a 95% two-tailed confidence interval, it is concluded that not enough evidence is present to reject the null hypothesis. Therefore, it appears that there is no difference in the mean and mean difference PM10 values between the two monitoring sites.



3.3 TSP

The results of TSP sampling to date indicate values well below the previously existing ambient air quality standard. This comparison was made in Section 2. Additionally, the work plan calls for a comparison of 3 TSP samples in which the wind speed (during sample collection) exceeded 15 knots. This equates to a mean wind speed of 17 miles per hour.

The data to date is sparse and consists of only 6 valid samples. Only two of the 6 sample days exhibited wind speeds exceeding 17 miles per hour. For interest, however, the results of TSP sampling is compared against the daily mean wind speed for the respective sampling days in the table below.

Table 8
TSP vs Wind Speed
TSP
Livingston, MT

Sample Date	($\mu\text{g}/\text{m}^3$)	(mph)
11/17/90	33	12
11/25/90	44	26
12/ 1/90	20	13
12/ 7/90	34	21
12/14/90	33	16
12/19/90	12	13



The data above has been plotted on a graph in Figure 4 below for review. The least squares regression line is plotted in the figure for interest. The correlation coefficient is 0.74. From a statistical viewpoint this indicates that about 54% of the data fits the linear model well.

Several other relationships were tried including the log and square root of various parameters. These additional investigations did not improve the standard error or the correlation coefficient.

It is noteworthy, however, that even the highest recording reading was less than 20% of the outdated TSP ambient air quality standard.

3.4 PNAs

A total of 6 samples were collected for PNAs. The results of these samples are provided in Appendix A with the original laboratory results found in Appendix C. Although the quantity of data is lengthy, there are a few comments and observations worth noting.

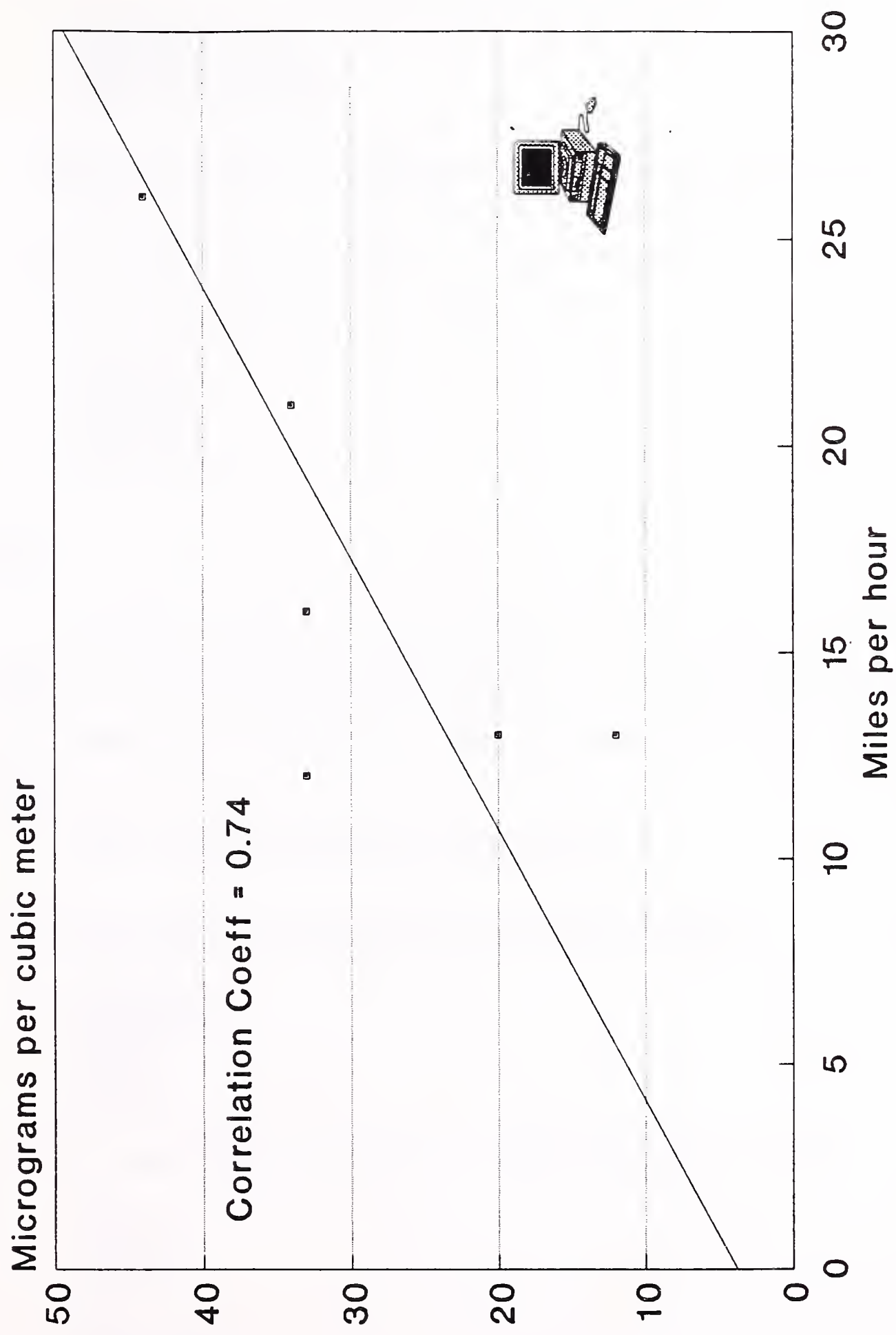
The "total" concentration of each PNA is determined by adding the collected PNA on both the filter and the polyurethane foam (PUF) cartridge. In many cases, however, the reported filter and PUF values were less than detectable. For purposes of analysis, if both the filter and cartridge data were less than detectable, then the total concentration was noted as less than detectable (less than the sum of the two below-detection values). If either one of the units were considered detectable, then the total value was listed as detectable. A few observations are noted:

1. No detectable values of any of the following compounds were found in any sample:

benzo(a)anthracene
benzo(a)pyrene



TSP vs Wind Speed Livingston, Montana



Nov/Dec, 1990



benzo(ghi)perylene
benzo(k)fluoranthene
dibenzo(a,h)anthracene
ideno(1,2,3-cd)pyrene.

2. There were a total (excluding blanks) of 192 sample analyses conducted. Of these samples only 21% (41) were reported above detectable limits.
3. Very few filter analyses indicated values above detectable.
4. The most common detectable compounds were:

fluoranthene
fluorene
naphthalene
phenanthrene

3.5 Metals

A total of 34 elements were analyzed on 6 upwind and 6 downwind PM10 samples. The sample dates coincided to allow for a comparison between the two locations. A summary of the mean concentrations of these metals was provided above as Table 6.

A few comments concerning the metals follow:

1. No detectable values were noted for the following elements:

Aluminum
Phosphorous
Nickel
Gallium
Mercury.

2. The elements which accounted for the highest concentrations include:

Sulfur
Potassium
Calcium
Titanium
Iron
Molybdenum
Lanthanum



Interestingly, almost all of the above elements are common crustal materials. Iron, calcium, titanium, and sulfur in particular are among the most common elements found.

3. None of these elements appear to be in any concentrations of concern. Both elements were found on the blank filter at about the same or higher concentrations than found on the exposed filters. Thus, the presence of these elements may be due more to filter background material than collected material in the air.

The presence of low levels of molybdenum (Mo) and Lanthanum (La) is somewhat curious. Mo is found in several ore bodies such as molybdenite (MoS_2), powellite ($\text{Ca}(\text{MoW})\text{O}_4$), and wulfenite (PbMoO_4), but it is not a common earth material. Mo can be found in industrial applications such as an ingredient in high-strength steel (a few % at best) or in lubricants as a sulfide.

Lanthanum is considered a rare-earth element. Its industrial applications include uses as an ingredient to improve glass's resistance to alkalinity, iron casting, and studio lighting.

It is useful to make some comparisons between upwind and downwind sites. The results lend themselves to a statistical comparison between the two sites. A paired t-test was used as one unbiased method to determine if there was a difference in concentration of any element between the two locations. The table below provides a summary of the results of this analysis.



Table 9
Upwind vs Downwind Elements
Livingston, MT

Element	Mean Difference	Standard Deviation	T Statistic
Aluminum	0.0000	0.0000	---
Phosphorus	0.0000	0.0000	---
Sulfur	0.0874	0.0483	4.43
Chlorine	-0.1740	0.2993	-1.42
Potassium	-0.0295	0.1742	-0.41
Calcium	0.1585	0.1402	2.77
Titanium	0.0039	0.0135	0.72
Vanadium	-0.0004	0.0024	-0.42
Chromium	0.0003	0.0005	1.19
Manganese	0.0031	0.0030	2.56
Iron	0.2447	0.1302	4.60
Nickel	0.0000	0.0000	---
Copper	-0.0001	0.0050	-0.07
Zinc	-0.0889	0.1987	-1.10
Gallium	0.0000	0.0000	---
Germanium	-0.0002	0.0003	-1.23
Arsenic	-0.0043	0.0068	-1.55
Selenium	0.0006	0.0006	2.34
Bromine	-0.0102	0.0172	-1.45
Rubidium	-0.0004	0.0024	-0.44
Strontium	0.0011	0.0031	0.84
Yttrium	0.0013	0.0034	0.91
Zirconium	0.0004	0.0073	0.14
Molybdenum	0.0006	0.0075	0.21
Palladium	0.0125	0.0143	2.13
Silver	0.0056	0.0106	1.28
Cadmium	-0.0152	0.0268	-1.39
Indium	0.0028	0.0234	0.29
Tin	-0.0039	0.0370	-0.26
Antimony	0.0005	0.0249	0.05
Barium	-0.0054	0.0416	-0.32
Lanthanum	0.1020	0.3012	0.83
Mercury	0.0000	0.0000	---
Lead	-0.0649	0.0948	-1.68

Note:

1. Units are in micrograms/cubic meter.
2. A positive mean difference indicates that the upwind site had larger values than the downwind site.



Using a 95% two-tailed confidence interval, the "critical" t-statistic is 2.57. Any t-statistic in the above table which is either greater than 2.57 or less than -2.57 falls outside of the 95% level. Such a number indicates that there is sufficient statistical evidence to reject the null hypothesis that the mean difference between the two sites (for the element in question) is zero (i.e. the means are the same).

A review of the table indicates that there are only three cases in which the null hypothesis may be rejected: sulfur, calcium, and iron. In all cases, the values recorded at the upwind site were greater than values at the downwind site.

The practical results of this statistical inference is probably minimal at best. Both iron and sulfur are common crustal material and would have little health implications at the concentrations measured.

The above analysis has calculated a total of 34 t-statistics. If, in fact, one were to conduct 34 t-tests on two unbiased Gaussian distributions whose means were equal, the probability of obtaining at least either one, two, or three rejects is 57%. The probability of obtaining exactly 2 rejects is 27%, while finding exactly three rejects is 15%. Thus, there is a good chance of finding several rejects due to random chance even if the two sites have identical means for each element.



APPENDIX A

Data Results



PM10 Data

(Appendix A)



Bison Engineering Inc

Helena, MT 59601

PM10 Particulate Summary

1990 Site & Area: 1111 3

Upwind Site Livingston, MT Envirocon

(Values are in Micrograms per Cubic Meter)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	-	-	-	-	-	-	-	-	-	-	-	18
2	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	11
8	-	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	11	-
11	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	10
15	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	20	25
20	-	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-	-	18	14
26	-	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-	13
No.	0	0	0	0	0	0	0	0	0	0	3	6
Max											20	25
Avg											16	15



Bison Engineering Inc

Helena, MT 59601

PM10 Particulate Summary

1990

Site & Area: 1111

4

Downwind Site

Livingston, MT

Envirocon

(Values are in Micrograms per Cubic Meter)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	-	-	-	-	-	-	-	-	-	-	-	12
2	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	12
8	-	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	10	-
11	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	18
15	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	13	10
20	-	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-	-	18	14
26	-	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-	16
No.	0	0	0	0	0	0	0	0	0	0	3	6
Max											18	18
Avg											14	14



Bison Engineering Inc.
Helena, MT 59601

SUMMARY STATISTICS FOR THE PM10 PARTICULATE DATA

1990

Site #	Upwind Site			Livingston, MT			Envirocon			Total # Obs.
	Min	Max	2nd Max	# > 150	Arith. Mean	Arith. Std Dev	Geo. Mean	Geo. Std Dev		
3	10	25	20	0	16	5	15	1.4	9	
4	10	18	16	0	14	3	13	1.3	9	



TSP Data

(Appendix A)



Bison Engineering Inc

Helena, MT 59601

Total Suspended Particulate Summary

1990 Site & Area: 1111 4

Downwind Site Livingston, MT Envirocon

(Values are in Micrograms per Cubic Meter)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	-	-	-	-	-	-	-	-	-	-	-	20
2	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	34
8	-	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	33
15	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	33	-
18	-	-	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	-	12
20	-	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-	-	44	-
26	-	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-	-
No.	0	0	0	0	0	0	0	0	0	0	2	4
Max											44	34
Avg											39	25



Bison Engineering Inc.
Helena, MT 59601

SUMMARY STATISTICS FOR THE TSP PARTICULATE DATA

1990

Site #	Downwind Site			Livingston, MT			Envirocon		Total # Obs.
	Min	Max	2nd Max	# > 150	Arith. Mean	Arith. Std Dev	Geo. Mean	Geo. Std Dev	
4	12	44	34	0	29	11	27	1.6	6



Meteorological Data

(Appendix A)



BISON ENGINEERING INC.
HELENA, MONTANA

NOVEMBER 1990

*** WIND SPEED SUMMARY ***

DAY	HOURS																								AVG.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21.9	18.9	17.7	24.4	20.8	23.5	24.4	20.9	21.0	21.5
12	22.2	24.5	23.7	22.6	23.6	21.2	20.7	22.7	25.6	25.8	21.7	24.1	24.9	26.2	28.9	34.3	32.0	30.9	28.2	26.9	27.7	27.5	29.6	28.2	26.0
13	22.2	24.5	23.7	22.6	23.6	21.2	20.7	22.7	25.6	25.8	21.7	24.1	24.9	26.2	28.9	34.3	32.0	30.9	28.2	26.9	27.7	27.5	29.6	28.2	26.0
14	25.1	21.2	18.3	20.4	23.0	24.4	25.7	24.8	22.3	22.2	21.5	16.4	14.8	18.1	19.1	18.2	11.5	5.0	7.8	11.8	6.7	5.7	3.9	5.7	16.4
15	2.8	1.8	2.0	4.5	4.7	8.6	8.9	8.3	8.5	9.9	12.1	16.5	15.0	15.5	16.9	13.9	12.9	11.1	11.5	11.6	12.3	10.9	12.0	13.9	10.3
16	14.1	15.7	15.0	16.4	16.3	16.2	17.5	18.2	17.7	19.9	21.9	21.7	14.5	15.5	12.6	11.8	13.2	11.8	15.0	9.2	6.1	8.6	15.0	15.3	15.0
17	13.2	10.2	10.9	11.2	9.8	11.1	13.4	12.3	17.7	13.8	12.7	8.8	9.7	12.1	15.8	15.6	16.0	12.7	10.1	10.5	10.1	10.5	10.8	9.6	12.0
18	8.6	8.7	9.4	7.3	7.1	8.4	16.5	16.9	18.0	14.3	11.3	12.8	9.9	13.3	12.6	11.5	11.0	8.1	10.6	10.9	6.1	10.9	10.4	4.9	10.8
19	8.0	11.4	10.3	5.6	4.0	2.6	3.5	3.2	4.6	9.3	18.1	19.1	20.9	22.5	21.7	19.8	18.4	15.1	8.4	9.2	10.4	11.1	6.8	11.1	11.5
20	11.3	8.0	4.2	3.0	2.5	2.7	3.7	4.6	3.2	8.9	11.6	15.7	22.8	11.0	6.8	11.8	11.2	14.7	9.7	6.3	6.7	6.7	10.7	9.2	8.6
21	15.2	19.4	20.9	21.2	29.2	30.4	18.9	17.0	13.2	17.0	17.5	18.3	22.1	20.7	22.8	22.9	20.8	22.7	18.8	20.3	24.3	25.7	24.8	23.8	21.2
22	24.5	26.8	26.2	33.7	34.9	31.0	31.5	32.6	26.9	25.4	26.2	27.2	30.9	29.2	25.2	21.5	18.0	16.9	22.7	24.6	20.9	19.8	29.3	31.8	26.6
23	27.2	26.8	26.1	23.9	24.0	26.4	27.6	29.1	26.0	21.3	21.5	26.5	22.5	27.4	23.6	22.1	25.3	31.9	28.8	30.3	25.7	25.4	28.4	27.8	26.1
24	25.5	26.8	26.4	22.4	28.2	26.7	30.3	31.7	26.7	30.6	29.5	31.1	35.2	31.3	30.1	27.8	29.6	34.1	30.7	33.2	30.1	29.7	31.6	28.1	29.5
25	32.5	30.3	34.7	35.7	30.3	33.9	30.7	32.5	30.9	27.5	28.9	31.7	31.8	34.4	29.5	27.5	20.2	13.9	14.5	16.1	23.6	18.2	6.5	4.0	25.8
26	3.7	4.6	5.5	4.2	2.5	3.2	4.4	4.9	6.3	5.7	4.0	2.0	1.7	2.0	9.6	11.4	10.1	8.9	8.5	8.3	10.0	13.1	15.2	14.8	6.9
27	14.4	16.3	16.4	16.5	9.1	8.1	11.4	12.5	14.8	15.7	18.4	20.3	25.1	17.8	15.4	16.3	17.8	17.3	13.9	13.5	16.0	18.0	17.1	17.7	15.8
28	20.8	14.8	13.2	11.5	13.6	9.4	11.5	10.1	10.0	15.3	14.8	15.5	18.0	18.2	18.3	20.0	20.1	19.1	23.8	25.8	22.7	28.1	23.9	35.2	18.1
29	27.0	27.2	29.2	30.9	30.5	27.6	30.3	28.1	25.2	28.7	30.8	33.0	36.0	36.3	31.4	33.5	34.8	38.2	37.1	32.4	31.0	30.5	30.3	27.1	31.1
30	27.8	25.6	27.0	28.5	19.8	10.4	8.6	7.7	7.7	17.3	11.4	15.8	21.0	19.5	16.0	16.4	15.0	18.6	17.0	14.9	12.3	10.0	10.6	4.7	16.0
AVG.	18.2	18.1	18.1	18.0	17.7	17.0	17.7	17.9	17.4	18.7	18.7	20.0	21.1	20.9	20.3	20.6	19.4	19.0	18.5	18.2	17.7	18.1	18.4	18.1	

of Valid Hours = 465 % Data Completeness = 64.6



BISON ENGINEERING INC. HELENA, MONTANA

NOVEMBER 1990

*** WIND DIRECTION SUMMARY ***

DAY	HOURS																								AVG.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1	213	209	214	217	216	212	218	217	212	219	212	215	215	215	221	214	221	218	214	205	220	237	237	215	225.0
2	213	209	214	217	216	212	218	217	212	219	212	215	215	215	221	214	214	213	210	215	217	217	218	220	215.8
3	217	213	211	209	211	211	213	212	212	209	216	257	268	278	273	270	283	25	342	341	308	348	24	304	209.0
4	174	133	101	236	221	246	269	273	253	252	262	277	283	282	281	256	267	267	267	264	264	225	226	230	276.0
5	226	227	219	212	210	203	195	200	208	201	197	194	194	204	224	249	245	233	225	246	264	238	260	261	272.8
6	235	243	235	240	238	237	229	223	222	231	230	268	252	271	270	266	268	259	253	250	236	231	238	239	271.0
7	245	248	249	249	246	258	284	280	280	258	229	215	247	260	247	266	276	249	227	234	260	267	251	240	270.3
8	251	234	221	283	59	260	31	10	10	242	215	211	205	203	214	212	207	211	227	215	216	220	166	214	271.3
9	211	189	355	44	113	22	349	9	32	205	193	261	266	313	75	276	276	249	243	268	262	257	261	222	273.9
10	241	213	209	223	221	222	225	220	236	237	220	244	252	244	213	212	215	212	221	219	215	215	214	214	150.5
11	215	207	218	222	212	214	210	218	222	230	235	243	254	253	258	250	242	232	221	217	219	217	218	216	176.2
12	218	215	218	218	218	215	218	214	215	218	215	210	200	204	204	214	208	214	217	221	221	227	224	215	200.9
13	197	203	210	216	205	204	202	197	203	194	199	205	205	213	215	217	213	208	214	219	215	214	207	216	205.5
14	213	213	213	210	210	208	211	215	215	211	213	214	213	211	214	214	215	247	260	259	275	317	353	126	204.4
15	164	96	52	92	136	209	247	311	31	34	29	335	1	354	268	267	259	242	232	233	242	256	250	254	12.1
16	245	255	264	270	269	228	245	230	233	231	215	218	220	227	242	255	249	252	245	251	248	256	258	247	245.8
17	250	256	258	264	247	263	260	253	241	231	237	238	256	259	262	274	272	264	237	217	217	216	235	216	251.7
18	219	216	217	216	220	222	209	206	206	202	209	208	204	206	215	219	216	214	219	219	216	216	217	215	217.9
19	212	214	216	215	238	2	271	233	231	266	272	249	263	263	260	253	249	251	250	249	252	251	279	266	251.1

of Valid Hours = 465 % Data Completeness = 64.6



BISON ENGINEERING INC. HELENA, MONTANA

NOVEMBER 1990

*** WIND FREQUENCY SUMMARY ***

DIR--> SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	
0.0 - 4.0	0.6	1.1	0.2	0.2	0.2	0.2	0.6	0.2	0.2	0.2	0.0	0.0	0.0	0.2	0.0	0.0	0.4	4.5
4.0 - 7.5	0.9	0.6	0.2	0.2	0.4	0.0	0.0	0.2	0.0	0.0	0.4	1.1	1.1	1.1	0.4	0.4	0.2	6.2
7.5 - 12.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.9	4.5	6.9	4.9	0.2	0.2	0.2	0.4	18.5
12.1 - 19.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	6.0	9.0	4.7	0.6	0.2	0.2	0.0	23.0
19.0 - 24.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5	6.9	1.7	1.7	0.0	0.0	0.0	0.0	17.8
24.7 - 30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.5	10.5	0.6	0.0	0.0	0.0	0.0	0.0	17.6
30.0 - 40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5	4.5	0.2	0.0	0.0	0.0	0.0	0.0	12.3
40.0 - 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OVER 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	1.7	1.7	0.4	0.4	0.6	0.2	0.6	0.4	0.4	24.9	32.9	19.6	12.7	1.3	0.9	1.1		
AVG. SPEED	4.7	4.3	4.3	5.4	3.6	2.5	2.8	5.3	5.4	25.5	22.0	14.1	13.4	11.6	10.2	6.2		

Calm Hours = 0.0%

Total Hours With Both Speed and Direction = 465

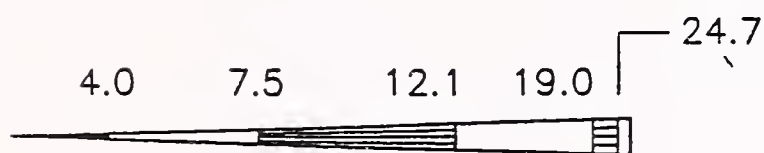
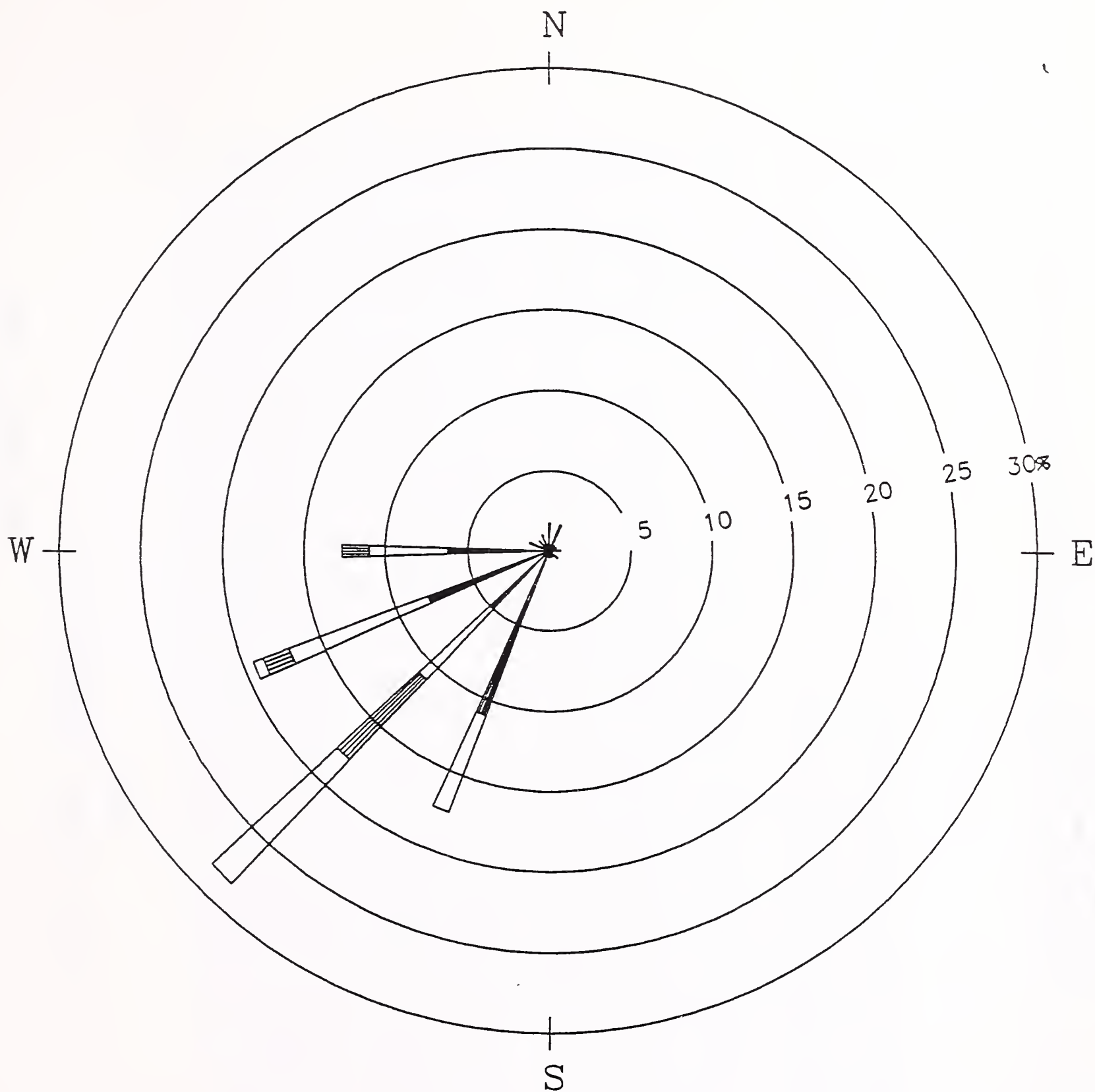
Average Wind Speed = 18.7 (MPH)

Resultant Windspeed = 16.8 (MPH)

Resultant Wind Direction = 225.4 Deg

Wind Persistence = 89.8 %





Wind Speed Class Boundaries
(Miles/Hour)

NOTES:

Diagram of the Frequency of
Occurrence for each Wind Direction.
Wind Direction is the Direction
From Which the Wind is Blowing.

WINDROSE

Livingston - Downwind
PERIOD: Nov. 1990

BISON ENGINEERING INC.
HELENA, MONTANA

DECEMBER 1990

*** WIND SPEED SUMMARY ***

DAY	HOURS																								AVG.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1	9.6	9.0	10.1	11.5	10.9	6.6	4.5	4.2	3.3	3.6	8.4	15.2	17.3	18.4	16.5	18.0	20.5	20.7	20.1	19.0	18.6	15.7	11.2	7.3	12.5
2	6.4	6.1	12.4	9.2	7.3	8.6	9.7	10.3	8.3	10.8	11.6	15.5	16.6	17.3	23.1	16.3	12.7	13.9	14.4	14.7	15.1	14.8	15.3	16.0	12.8
3	12.3	10.9	10.4	15.8	14.9	15.2	16.5	17.4	17.9	20.8	20.9	19.8	18.9	17.8	21.0	20.9	24.6	22.5	24.6	22.9	24.2	26.6	28.6	33.2	19.9
4	32.0	30.6	33.5	30.6	30.1	28.9	25.7	21.1	22.2	26.5	27.0	27.0	31.0	36.6	40.3	35.3	36.2	31.1	30.1	27.8	30.7	25.7	23.4	18.6	29.2
5	23.7	21.6	18.8	15.6	14.0	16.3	18.9	12.8	12.6	15.2	18.4	20.3	22.0	21.8	20.3	19.3	14.3	10.1	9.6	8.9	12.3	15.5	11.0	10.5	16.0
6	12.2	11.3	11.8	13.6	14.6	13.1	14.5	15.2	16.6	18.6	16.2	18.1	18.0	17.7	14.9	17.2	14.9	16.3	18.0	21.6	22.1	24.0	21.8	22.4	16.9
7	22.5	23.6	25.3	25.5	23.6	21.0	23.3	20.6	21.6	22.9	29.2	26.3	19.9	18.8	17.2	18.1	18.4	19.1	19.0	21.0	19.5	13.5	15.3	14.9	20.8
8	21.3	19.2	20.2	21.5	21.2	20.2	26.1	25.1	25.7	25.0	24.9	18.7	22.1	21.2	18.6	19.3	21.5	22.9	23.2	22.8	28.3	21.7	25.2	23.7	22.5
9	24.1	22.8	22.7	22.6	23.2	23.2	20.9	23.2	22.2	22.9	20.1	19.9	20.8	16.0	18.2	21.2	21.2	24.2	24.5	22.9	20.4	19.3	24.3	22.9	21.9
10	20.8	21.3	22.9	24.2	22.1	23.0	21.2	21.5	24.9	22.9	21.2	21.2	22.9	21.4	19.7	22.2	24.2	25.0	24.3	21.2	20.1	19.8	17.8	17.3	21.8
11	20.8	19.7	11.8	18.2	22.7	24.0	20.2	19.3	19.2	11.1	6.2	3.7	2.9	3.3	3.3	8.8	4.0	8.4	12.8	8.5	10.4	12.2	10.7	9.1	12.1
12	9.2	11.1	9.5	8.6	6.5	7.4	7.2	7.4	4.1	8.7	11.3	12.4	10.4	8.2	6.5	2.9	1.0	1.8	1.2	1.0	1.0	1.0	1.0	1.1	5.9
13	1.5	1.7	2.1	2.8	2.4	1.1	1.2	1.0	1.0	1.1	3.6	3.6	2.7	6.5	15.5	14.2	12.7	1.8	1.0	1.0	1.5	1.1	1.2	2.8	3.5
14	6.9	8.3	14.3	11.7	12.7	11.5	8.7	8.5	10.1	14.2	17.1	18.4	18.6	20.7	20.5	18.9	13.2	11.2	17.4	19.9	18.6	23.2	25.7	26.0	15.7
15	24.2	25.6	28.3	27.8	27.0	23.3	24.2	26.0	30.0	29.4	29.3	26.6	21.6	20.6	18.6	20.3	20.3	19.2	17.3	19.4	16.5	14.6	14.3	16.8	22.6
16	14.1	14.9	11.8	16.3	18.0	14.9	14.5	15.4	15.5	15.4	13.7	12.5	12.5	11.1	9.6	11.4	14.0	10.2	8.4	7.8	6.5	12.8	8.5	11.1	12.5
17	13.2	13.2	13.8	12.3	13.3	15.4	13.8	20.7	18.3	16.4	16.5	18.6	21.2	23.9	21.6	19.4	26.0	21.4	29.9	29.2	27.0	24.4	26.6	23.5	20.0
18	17.8	19.0	21.4	21.4	17.6	19.5	16.9	11.1	12.7	10.9	16.3	19.3	18.8	20.0	18.2	17.6	16.2	14.0	12.6	12.3	5.3	6.5	10.0	11.8	15.3
19	16.8	16.0	9.9	5.6	5.0	8.8	7.3	8.3	3.6	14.4	13.1	10.4	14.0	16.7	15.8	15.8	16.5	17.9	16.5	17.1	18.7	18.4	16.6	16.9	13.3
20	16.9	16.5	15.6	15.8	15.5	13.7	13.5	15.4	13.9	19.1	19.0	17.8	18.1	19.2	19.1	19.5	17.6	18.3	17.5	17.9	18.1	14.5	15.8	16.3	16.9
21	15.5	13.1	10.6	7.2	7.1	7.0	6.7	5.8	4.6	4.1	2.8	3.0	2.4	2.8	2.4	1.7	2.3	5.9	11.9	12.3	13.0	14.6	11.9	11.0	7.5
22	13.0	12.9	11.4	12.4	12.8	14.0	13.3	15.2	16.8	16.4	17.7	19.3	19.4	19.7	17.6	15.5	15.7	15.2	17.9	17.0	16.7	16.2	17.7	19.1	16.0
23	17.8	18.5	18.5	16.5	18.0	20.9	19.5	21.0	18.8	23.2	26.0	26.9	24.3	27.5	24.1	26.2	30.7	31.3	31.7	33.9	30.1	31.0	25.7	25.2	24.5
24	25.3	27.2	27.4	24.6	27.5	26.4	26.8	29.6	29.2	23.7	26.6	27.6	27.8	21.0	20.9	20.0	21.2	20.1	17.4	14.6	11.7	8.9	10.5	7.5	21.8
25	4.4	4.9	11.4	12.0	16.0	16.8	21.0	21.6	25.5	27.2	25.4	22.7	19.6	22.8	22.4	22.6	27.2	25.3	23.5	23.2	19.9	19.3	18.7	18.9	19.7
26	18.5	16.9	17.5	17.8	16.7	16.6	19.3	19.3	20.4	23.9	20.3	21.2	20.6	22.2	23.7	24.6	-	-	-	-	-	-	-	-	20.0
27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AVG.	16.2	16.0	16.3	16.2	16.2	16.1	16.1	15.9	16.2	17.2	17.9	17.9	17.8	18.4	18.0	17.9	17.9	17.1	17.8	17.5	17.1	16.6	16.4	16.2	16.2

of Valid Hours = 616

% Data Completeness = 82.8



BISON ENGINEERING INC. HELENA, MONTANA

DECEMBER 1990

*** WIND DIRECTION SUMMARY ***

DAY	HOURS																								AVG.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1	261	245	250	250	250	265	35	37	73	6	223	209	208	205	207	212	209	209	212	215	224	222	231	249	219.4
2	270	283	253	257	217	230	247	240	233	256	253	253	258	259	265	253	245	222	222	237	247	240	232	258	240.2
3	233	253	233	218	233	222	233	230	216	235	237	233	236	240	238	230	245	227	226	248	230	218	224	220	235.1
4	226	210	214	212	218	213	220	226	232	218	217	219	218	218	216	218	216	214	209	207	207	213	216	237	228.5
5	260	258	248	245	258	257	275	268	244	243	264	272	263	269	269	279	255	241	245	251	266	275	263	265	273.4
6	266	259	239	230	236	241	241	232	228	218	223	213	214	215	223	220	233	221	232	229	221	219	215	216	272.8
7	219	215	206	212	205	209	211	216	224	209	215	219	223	230	224	227	223	211	214	215	230	248	256	251	262.2
8	249	228	237	240	248	245	240	247	240	236	233	232	234	231	226	237	233	231	234	233	220	222	223	224	242.8
9	218	220	220	222	222	212	229	235	229	227	229	217	213	210	210	204	210	213	219	225	213	220	210	213	228.7
10	217	215	215	215	216	214	216	217	213	214	216	214	222	217	211	208	208	213	218	215	216	215	211	206	224.5
11	225	235	253	234	226	218	216	222	253	306	343	11	22	157	16	259	311	257	255	291	263	256	251	246	235.8
12	246	266	271	254	248	246	247	244	255	228	214	199	202	200	210	291	305	220	235	21	15	12	21	11	308.7
13	46	52	15	40	2	318	276	22	27	174	73	51	91	278	265	262	273	5	339	163	217	214	189	238	328.1
14	263	255	260	259	262	266	241	240	248	245	244	251	248	256	265	261	237	232	230	241	231	218	218	220	292.6
15	222	228	229	223	227	228	231	233	231	228	213	227	234	216	224	221	225	223	221	231	223	235	230	232	222.4
16	230	209	204	211	215	215	226	224	226	224	227	225	219	218	231	253	273	265	260	240	241	262	234	230	225.6
17	222	216	216	233	231	232	237	228	238	230	230	232	243	225	206	208	222	219	217	203	198	206	214	216	221.7
18	237	243	238	254	236	258	300	9	13	46	342	332	334	340	343	354	347	359	340	348	21	10	350	2	338.9
19	351	350	332	329	11	6	355	344	319	352	2	49	58	67	55	56	55	66	74	73	65	66	60	59	0.0
20	61	65	58	59	55	46	39	36	37	67	71	71	76	78	69	70	63	62	60	62	65	62	64	70	65.7
21	69	68	62	61	66	58	63	66	56	47	334	319	343	333	61	321	313	249	230	228	223	230	226	242	67.0
22	227	232	243	239	239	238	244	239	235	245	242	218	216	217	222	224	219	236	230	214	230	224	224	229	204.9
23	245	237	234	228	217	216	222	221	224	213	222	218	218	218	222	235	220	244	230	232	223	233	257	243	228.0
24	245	245	228	234	235	241	250	230	212	224	222	220	218	226	222	219	207	204	205	200	204	351	338	6	226.7
25	327	260	235	239	242	227	224	221	222	219	225	222	229	229	242	233	244	251	256	228	227	239	225	219	230.5
26	225	220	219	229	233	234	236	243	236	225	226	212	217	238	240	229	-	-	-	-	-	-	-	-	227.7
27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

of Valid Hours = 616 % Data Completeness = 82.8



BISON ENGINEERING INC. HELENA, MONTANA

DECEMBER 1990

*** WIND FREQUENCY SUMMARY ***

DIR---->	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
SPEED																	
(MPH)																	
0.0 - 4.0	0.8	1.5	0.6	0.5	0.2	0.0	0.0	0.0	0.3	0.2	0.5	0.2	0.2	0.2	1.1	0.6	7.1
4.0 - 7.5	0.6	0.2	0.6	0.8	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.8	1.3	0.2	0.0	0.5	5.4
7.5 - 12.1	0.8	0.0	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.8	2.3	5.2	1.5	0.2	0.2	0.5	11.9
12.1 - 19.0	1.0	0.2	1.3	4.2	0.0	0.0	0.0	0.0	0.0	2.9	14.3	7.3	2.3	0.2	0.0	1.0	34.6
19.0 - 24.7	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	4.7	17.2	3.9	1.3	0.0	0.0	0.3	28.1
24.7 - 30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	6.0	1.8	0.0	0.0	0.0	0.0	9.7
30.0 - 40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.9	0.2	0.0	0.0	0.0	0.0	3.1
40.0 - 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.2
OVER 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	3.2	1.8	2.9	6.3	0.2	0.0	0.0	0.0	0.3	11.7	42.5	19.8	6.0	0.6	1.3	2.9	
AVG. SPEED	9.1	2.9	9.4	14.6	2.7	0.0	0.0	0.0	1.2	20.9	20.3	15.6	13.5	8.6	3.5	10.4	

Calm Hours = 0.0%

Total Hours With Both Speed and Direction = 616

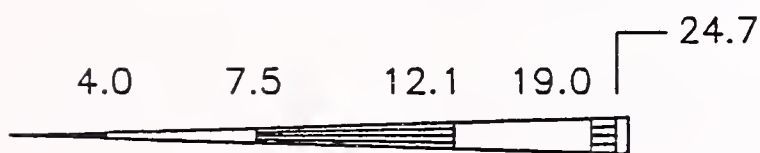
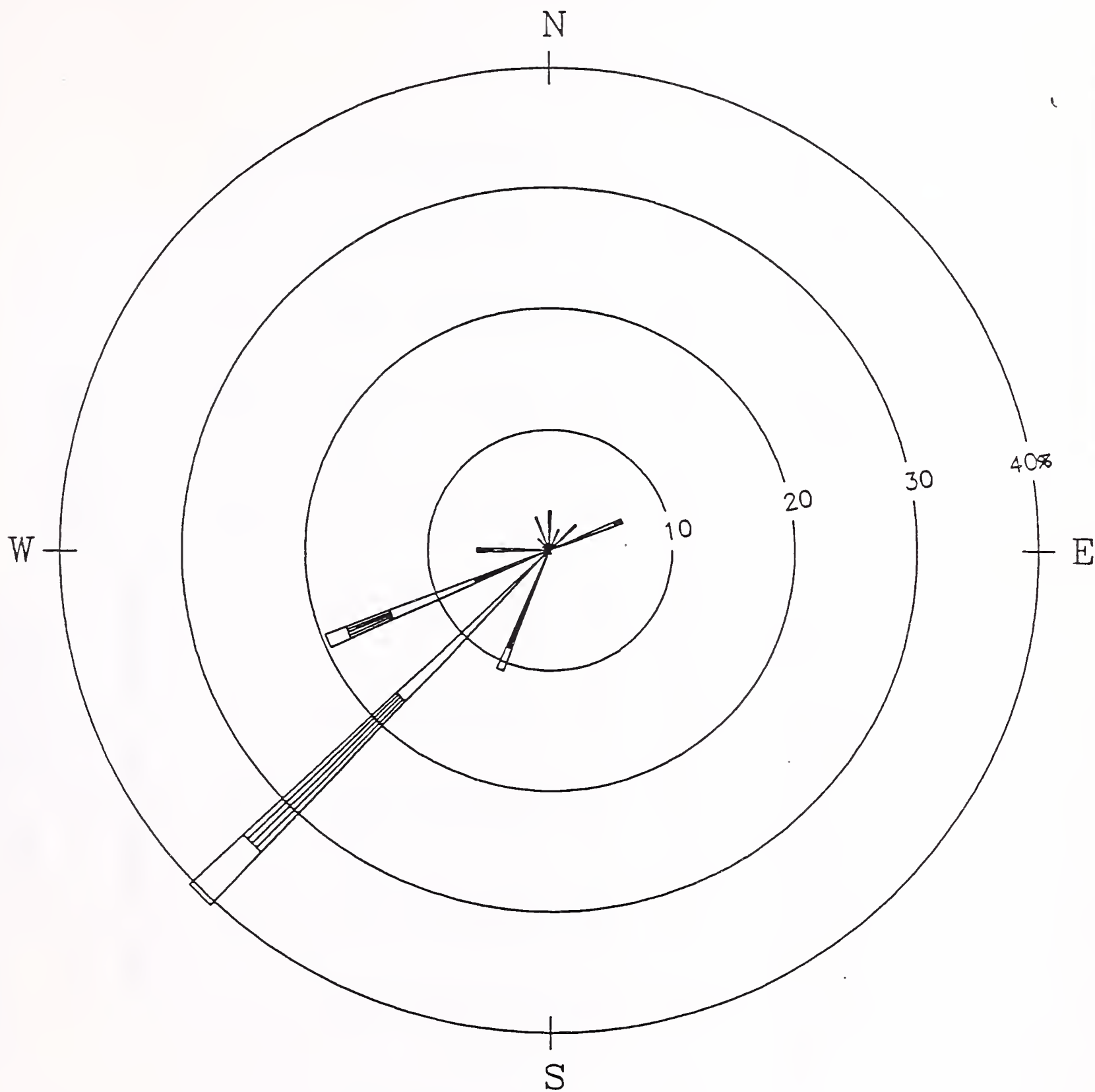
Average Wind Speed = 16.9 (MPH)

Resultant Windspeed = 12.9 (MPH)

Resultant Wind Direction = 229.7 Deg

Wind Persistence = 76.1 %





Wind Speed Class Boundaries
(Miles/Hour)

NOTES:
Diagram of the Frequency of
Occurrence for each Wind Direction.
Wind Direction is the Direction
From Which the Wind is Blowing.

WINDROSE

Livingston – Downwind
PERIOD: Dec. 1990

Bison
Engineering



BISON ENGINEERING INC HELENA, MONTANA

Envircon

Livingston, Montana

4th Q 1990

*** WIND FREQUENCY SUMMARY ***

DIR---->	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
SPEED (MPH)																	
0.0 - 4.0	0.7	1.3	0.5	0.4	0.2	0.1	0.3	0.3	0.3	0.2	0.3	0.1	0.2	0.1	0.6	0.6	6.0
4.0 - 7.5	0.7	0.4	0.5	0.6	0.2	0.0	0.0	0.1	0.0	0.1	0.3	1.2	0.9	0.3	0.2	0.4	5.7
7.5 - 12.1	0.6	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.1	0.8	3.2	5.9	3.0	0.2	0.2	0.5	14.7
12.1 - 19.0	0.6	0.1	0.7	2.4	0.0	0.0	0.0	0.0	0.0	2.7	10.7	8.0	3.3	0.4	0.1	0.6	29.6
19.0 - 24.7	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	5.9	12.8	3.0	1.5	0.0	0.0	0.2	23.7
24.7 - 30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9	8.0	1.3	0.0	0.0	0.0	0.0	13.1
30.0 - 40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	3.1	0.2	0.0	0.0	0.0	0.0	7.0
40.0 - 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
OVER 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TOTAL

2.6

1.8

3.8

0.4

0.1

0.3

0.4

0.4

17.4

38.4

19.7

8.9

0.9

1.1

2.1

AVG. SPEED

7.8

3.5

8.8

14.1

3.4

2.5

2.8

3.7

3.3

23.8

20.9

14.9

13.5

10.4

5.7

9.5

Calm Hours = 0.0%

Total Hours With Both Speed and Direction = 1081

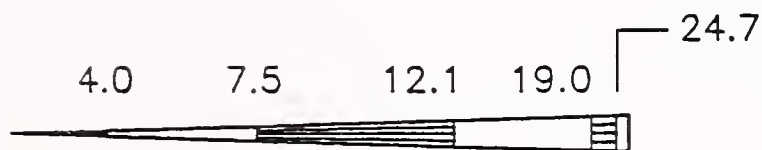
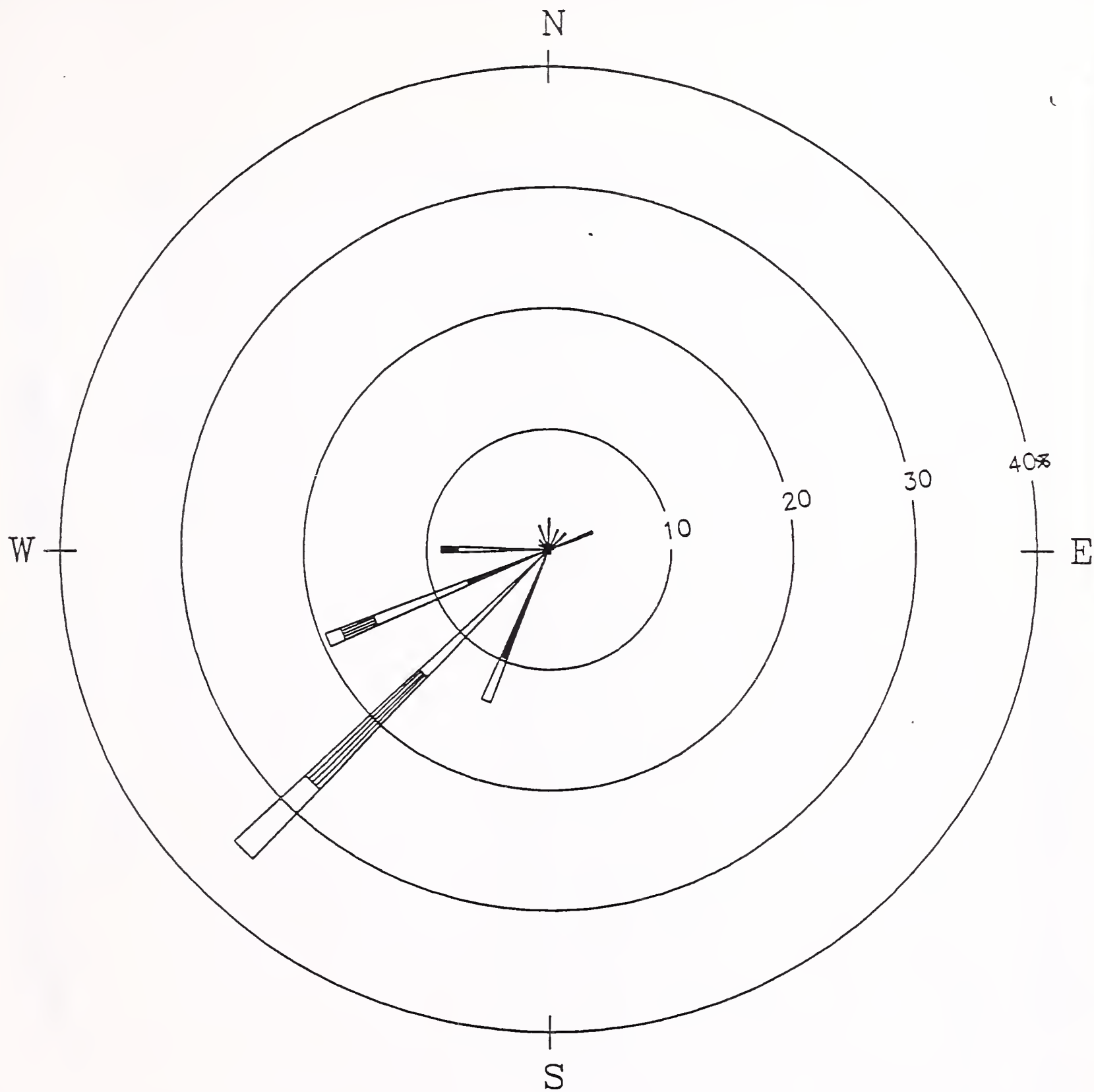
Average Wind Speed = 17.7 (MPH)

Resultant Windspeed = 14.5(MPH)

Resultant Wind Direction = 227.6deg

Wind Persistence = 82.2 %





Wind Speed Class Boundaries
(Miles/Hour)

NOTES:

Diagram of the Frequency of
Occurrence for each Wind Direction.
Wind Direction is the Direction
From Which the Wind is Blowing.

WINDROSE

Livingston - Downwind
4th Quarter - 1990

Bison
Engineering



BISON ENGINEERING INC.
HELENA, MONTANA

Envirocon *** TEMPERATURE SUMMARY (DEG F) *** NOVEMBER 1990

DAY	HOURS																								AVG.				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24					
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0				
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0				
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0				
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0				
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0				
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0				
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0				
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0				
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0				
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0				
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	66	64	61	59	57	57	55	55	55	59				
12	52	54	54	54	50	52	52	52	52	55	59	61	63	63	63	64	64	63	63	63	63	63	63	61	58				
13	52	54	54	54	50	52	52	52	52	55	59	61	63	63	63	64	64	63	63	63	63	63	63	61	58				
14	59	59	59	59	59	59	59	59	59	61	61	63	61	61	57	54	52	50	48	46	45	39	37	34	54				
15	32	32	32	34	34	34	34	32	34	34	36	36	37	37	37	39	37	36	37	36	36	34	32	34	35				
16	34	34	34	34	34	34	34	34	34	37	39	41	45	48	52	54	52	50	48	48	48	48	48	48	42				
17	46	46	45	45	45	43	45	45	45	46	50	54	55	55	54	54	52	48	45	45	45	45	45	45	47				
18	43	43	45	43	43	43	45	43	43	45	46	46	48	48	50	50	48	45	45	46	45	45	41	41	45				
19	41	43	41	39	32	32	30	28	32	45	48	52	52	52	52	50	50	48	48	48	46	46	45	45	44				
20	43	41	41	39	39	37	36	36	39	45	45	43	37	36	34	34	30	28	28	28	28	27	27	25	35				
21	27	27	28	30	30	30	30	30	30	30	34	36	37	36	34	32	34	34	34	36	37	37	37	37	33				
22	37	39	39	41	41	43	43	45	45	46	48	50	52	52	52	50	50	48	48	48	46	46	45	45	46				
23	45	45	45	45	45	45	45	45	46	48	50	52	54	52	54	52	50	48	48	50	50	52	52	50	49				
24	52	50	52	52	52	52	52	52	52	50	52	54	54	55	54	54	54	52	52	52	52	52	52	52	52				
25	52	52	52	52	52	52	52	52	52	52	52	54	54	54	54	54	54	54	46	45	45	37	34	32	50				
26	32	30	28	28	30	28	28	27	21	21	21	27	30	36	32	32	28	25	25	23	25	25	23	23	27				
27	23	21	23	21	19	19	19	19	19	23	23	27	27	28	30	30	28	27	25	27	27	27	25	25	24				
28	25	25	25	25	25	23	25	25	27	28	32	32	32	32	34	34	34	32	32	32	30	30	32	32	29				
29	32	34	34	34	34	36	36	36	37	37	39	41	41	43	45	45	43	41	41	41	43	43	43	43	39				
30	43	43	43	41	39	32	30	30	30	30	32	36	34	34	32	32	30	28	27	25	23	23	21	21	32				
31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0				
AVG.	40	41	41	40	40	39	39	39	39	42	43	45	46	46	46	47	46	44	43	43	43	42	41	40					
MINIMUM T = 19										AVERAGE T = 42										HOURS OF DATA = 465									
MAXIMUM T = 66																													



BISON ENGINEERING INC.
HELENA, MONTANA

Envirocon *** Livingston, Montana *** DECEMBER 1990
*** TEMPERATURE SUMMARY (DEG F) ***

DAY	HOURS																								AVG.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1	21	19	18	16	18	18	10	9	16	18	27	32	34	34	36	34	32	32	32	32	32	32	32	30	25
2	28	28	27	27	27	27	25	25	25	25	27	27	27	28	28	28	27	27	25	27	27	27	27	28	27
3	27	27	27	27	27	27	25	25	27	27	30	34	37	39	39	39	36	36	34	34	34	34	32	32	31
4	34	34	34	34	36	36	36	36	37	39	43	43	45	45	45	45	45	45	43	43	43	43	43	43	40
5	45	39	36	36	36	36	36	34	34	34	34	36	36	36	36	32	30	30	30	28	30	30	30	30	34
6	30	28	28	28	27	27	27	27	27	27	28	30	34	36	37	39	37	36	36	36	34	34	32	32	31
7	32	32	30	30	30	30	30	30	30	32	34	37	41	43	45	46	45	43	41	41	39	39	39	37	37
8	39	37	37	37	36	36	36	36	36	39	41	46	48	52	52	52	50	48	46	46	45	45	45	45	43
9	45	45	45	45	45	45	45	45	45	46	50	54	55	59	59	59	55	54	54	52	52	52	52	50	50
10	50	50	50	50	48	48	48	48	50	50	54	57	59	59	59	59	57	57	57	55	55	55	55	54	54
11	55	55	52	52	50	48	48	48	46	39	34	34	34	34	34	36	32	32	34	32	32	30	28	27	39
12	25	25	25	23	21	21	21	21	21	23	25	27	28	30	30	30	27	23	19	16	14	14	12	12	22
13	12	14	14	14	14	14	14	14	16	21	27	28	34	32	30	30	28	28	28	27	27	27	27	25	23
14	25	25	25	23	23	23	23	23	25	25	25	27	27	27	27	27	25	23	23	23	23	23	23	23	24
15	21	21	23	23	23	23	23	23	23	23	25	27	28	30	32	34	32	32	30	30	30	28	27	27	27
16	27	25	25	25	25	25	25	25	25	27	28	28	30	30	30	32	30	28	27	25	28	28	27	27	27
17	27	25	25	25	23	23	25	25	27	27	30	28	32	30	30	32	32	30	32	30	30	32	36	36	29
18	34	36	36	37	34	36	28	16	12	7	5	3	3	1	1	-2	-6	-8	-9	-9	-11	-11	-13	-15	9
19	-17	-18	-18	-20	-18	-20	-20	-20	-22	-22	-20	-18	-17	-17	-17	-17	-17	-18	-18	-18	-18	-18	-20	-19	-19
20	-20	-20	-20	-22	-22	-22	-22	-22	-24	-22	-20	-20	-20	-18	-18	-18	-20	-20	-20	-20	-20	-20	-20	-20	-21
21	-22	-22	-22	-22	-22	-22	-22	-24	-24	-22	-18	-17	-15	-13	-15	-17	-18	-18	-18	-18	-18	-18	-18	-18	-19
22	-18	-18	-18	-18	-18	-18	-18	-17	-15	-13	-11	-9	-6	-4	-4	-2	-2	-0	-0	-0	-0	-0	-0	-2	-9
23	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-0	1	5	7	9	10	12	12	10	9	9	9	9	10	4
24	9	9	10	10	9	10	10	9	9	10	10	12	14	14	14	14	14	14	14	14	12	10	9	7	11
25	7	7	9	9	10	9	9	9	9	10	12	14	14	16	19	19	18	16	16	16	16	16	16	16	13
26	14	14	14	14	14	12	12	12	12	10	14	16	18	21	23	25	-	-	-	-	-	-	-	-	15
27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
AVG.	20	20	19	19	19	19	18	17	18	18	20	22	24	25	25	26	24	23	23	22	22	22	21	21	21

MINIMUM T = -24 MAXIMUM T = 59 AVERAGE T = 21 HOURS OF DATA = 616



BISON ENGINEERING INC.
HELENA, MONTANA

Envirocon *** Livingston, Montana NOVEMBER 1990
*** WIND SIGMA SUMMARY (DEGREES) ***

DAY	HOURS																								AVG.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	13	11	11	14	20	17	17	16	15
12	24	17	11	13	22	14	11	13	12	12	10	10	12	15	12	13	18	21	21	41	26	12	16	13	16
13	13	11	11	11	15	12	14	13	11	13	13	12	12	12	13	10	12	11	13	12	11	12	10	11	12
14	10	11	11	11	11	11	10	11	11	11	15	28	13	10	9	9	53	28	11	13	34	35	49	54	20
15	43	59	49	48	66	20	9	18	16	11	18	8	8	8	8	14	13	8	11	9	15	22	15	12	21
16	12	11	13	12	12	12	11	11	11	11	12	12	15	22	21	22	21	19	10	15	46	21	20	13	16
17	13	12	10	12	13	12	13	11	11	14	25	18	23	12	9	10	9	12	10	11	15	13	15	10	13
18	14	11	24	11	14	19	8	9	7	12	19	12	30	19	13	17	26	20	19	24	27	12	17	27	17
19	22	13	12	51	58	66	67	56	39	31	13	12	13	11	11	11	11	12	14	18	15	16	38	14	26
20	10	61	48	65	73	47	27	25	80	31	15	22	9	67	89	10	27	11	13	13	15	13	12	15	33
21	26	12	11	14	11	11	13	14	18	23	21	16	12	17	12	11	11	11	13	12	11	11	11	13	14
22	11	13	12	13	13	13	13	16	14	18	16	13	11	11	12	12	16	16	14	11	13	11	11	10	13
23	12	15	13	14	13	13	14	11	12	14	12	12	12	11	13	11	12	12	11	11	12	15	15	15	13
24	13	13	12	13	11	12	12	10	14	12	13	12	11	12	12	13	12	12	12	12	13	12	11	13	12
25	13	11	12	10	10	11	11	11	10	12	11	11	11	10	11	11	11	21	9	10	11	65	73	23	17
26	19	54	25	29	36	23	15	72	12	12	16	31	56	57	18	9	10	15	12	20	18	12	11	9	25
27	10	11	16	15	23	18	12	14	17	18	14	15	14	17	13	17	16	22	13	11	10	9	8	10	14
28	10	10	9	11	9	8	10	15	20	15	15	15	14	12	13	12	15	13	15	16	17	17	16	12	13
29	14	13	13	12	13	15	14	14	13	13	12	12	11	12	12	13	11	11	11	11	11	12	11	11	12
30	12	12	11	11	66	21	24	31	19	10	10	11	14	10	11	10	11	9	9	9	10	13	12	72	18
31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
AVG.	16	19	17	20	26	19	16	20	18	15	15	15	16	18	16	12	16	15	13	15	18	18	19	19	19



BISON ENGINEERING INC.
HELENA, MONTANA

Envirocon *** Livingston, Montana DECEMBER 1990
*** WIND SIGMA SUMMARY (DEGREES) ***

DAY	HOURS																								AVG.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1	14	10	8	8	10	54	23	56	50	54	52	14	12	12	13	12	10	11	12	11	13	15	15	35	22
2	38	45	10	11	23	25	17	14	15	14	13	12	11	11	10	12	12	12	13	14	12	14	16	10	16
3	16	13	13	10	17	15	15	18	14	17	14	18	19	18	15	16	17	17	15	18	20	15	15	16	16
4	17	14	13	20	16	13	17	19	20	15	13	12	12	12	12	11	11	11	13	11	11	13	12	13	14
5	15	11	11	13	22	13	12	17	12	18	11	13	11	11	11	10	16	10	10	12	11	8	14	11	13
6	9	8	14	12	11	13	13	15	17	12	16	13	13	18	15	13	14	13	12	14	17	12	15	13	13
7	31	22	11	12	10	13	11	13	12	12	16	16	13	12	11	12	12	10	10	13	15	16	17	18	14
8	16	20	13	15	12	17	15	16	21	14	21	19	20	22	19	23	18	19	17	17	16	14	14	14	17
9	13	14	13	16	13	13	16	14	14	16	18	17	15	16	16	14	13	11	11	15	13	14	11	11	14
10	11	11	10	10	13	11	11	13	12	12	13	12	12	11	11	11	11	10	11	11	11	12	12	12	11
11	11	16	22	15	13	12	12	15	23	35	52	73	67	14	76	13	40	69	10	16	14	8	8	10	27
12	10	8	9	39	28	12	10	11	22	14	15	11	10	15	15	56	52	18	69	36	46	23	16	27	24
13	22	32	33	35	39	57	81	51	44	79	46	35	30	66	9	8	12	68	67	60	82	38	39	23	44
14	14	10	9	8	9	11	13	17	12	11	10	11	10	12	9	10	15	14	11	19	22	14	15	15	13
15	15	13	15	13	16	15	17	16	13	14	10	15	16	14	15	14	13	13	12	12	17	19	17	16	15
16	18	13	21	11	11	12	11	11	11	12	12	12	12	16	15	19	8	22	18	16	20	9	17	14	14
17	12	11	11	17	13	14	15	12	15	16	19	17	17	15	16	19	17	20	14	14	14	18	17	19	16
18	27	19	19	14	21	13	37	66	37	37	15	9	11	10	10	14	18	15	22	32	61	55	17	20	25
19	13	14	19	46	17	15	16	19	58	18	16	17	14	11	11	12	10	10	10	10	9	9	10	10	16
20	10	9	10	10	11	11	11	10	13	11	9	8	9	9	9	9	9	9	9	9	10	10	9	8	10
21	8	10	11	12	11	12	11	9	11	23	34	35	40	27	44	27	44	15	12	12	12	13	13	15	19
22	13	14	16	12	13	12	10	11	11	13	13	13	13	13	12	11	17	16	15	15	15	14	18	18	14
23	13	16	16	16	14	12	12	11	14	11	12	11	12	11	13	12	15	14	16	14	13	18	17	20	14
24	18	19	16	19	17	18	16	15	15	18	14	15	13	17	17	14	12	12	12	18	14	36	17	33	17
25	42	25	17	16	16	15	9	12	12	11	13	12	16	17	17	17	15	15	12	20	17	19	14	13	16
26	14	12	11	14	14	13	11	12	14	14	16	16	17	20	17	17	-	-	-	-	-	-	-	-	15
27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
AVG.	17	16	14	16	16	17	17	19	20	20	19	18	17	17	17	16	17	18	17	18	20	17	15	17	17



PNA Data

(Appendix A)



PNA Sampling Results

PUFF Sampler
Downwind Site

Sample Number: Air-001
Sample Date: November 10, 1990
Units: Micrograms/cubic meter

	Filter	Adsorbent	Total
Acenaphthene	<0.0017	0.0024	0.0041
Acenaphylene	<0.0017	<0.0017	<0.0034
Anthracene	<0.0017	<0.0017	<0.0034
Benzo(a)anthracene	<0.0017	<0.0017	<0.0034
Benzo(a)pyrene	<0.0017	<0.0017	<0.0034
Benzo(b)fluoranthene	<0.0017	<0.0017	<0.0034
Benzo(ghi)perylene	<0.0017	<0.0017	<0.0034
Benzo(k)fluoranthene	<0.0017	<0.0017	<0.0034
Chrysene	<0.0017	<0.0017	<0.0034
Dibenzo(a,h)anthracene	<0.0017	<0.0017	<0.0034
Fluoranthene	<0.0017	0.0017	0.0034
Fluorene	<0.0017	0.0046	0.0063
Ideno(1,2,3-cd)pyrene	<0.0017	<0.0017	<0.0034
Napthalene	<0.0017	0.0028	0.0045
Phenanthrene	<0.0017	0.0182	0.0200
Pyrene	<0.0017	<0.0017	<0.0034

Sample Number: Air-002
Sample Date: November 19, 1990
Units: Micrograms/cubic meter

	Filter	Adsorbent	Total
Acenaphthene	<0.0016	0.0029	0.0046
Acenaphylene	<0.0016	<0.0016	<0.0033
Anthracene	<0.0016	0.0020	0.0036
Benzo(a)anthracene	<0.0016	<0.0016	<0.0033
Benzo(a)pyrene	<0.0016	<0.0016	<0.0033
Benzo(b)fluoranthene	0.0036	<0.0016	0.0052
Benzo(ghi)perylene	<0.0016	<0.0016	<0.0033
Benzo(k)fluoranthene	<0.0016	<0.0016	<0.0033
Chrysene	<0.0016	<0.0016	<0.0033
Dibenzo(a,h)anthracene	<0.0016	<0.0016	<0.0033
Fluoranthene	<0.0016	0.0056	0.0072
Fluorene	<0.0016	0.0082	0.0098
Ideno(1,2,3-cd)pyrene	<0.0016	<0.0016	<0.0033
Napthalene	<0.0016	0.0026	0.0042
Phenanthrene	<0.0016	0.0271	0.0287
Pyrene	<0.0016	0.0046	0.0062

Sample Number: Air-003
 Sample Date: November 25, 1990
 Units: Micrograms/cubic meter

	Filter	Adsorbent	Total
Acenaphthene	<0.0016	0.0023	<0.0039
Acenaphylene	<0.0016	<0.0016	<0.0032
Anthracene	<0.0016	<0.0016	<0.0032
Benzo(a)anthracene	<0.0016	<0.0016	<0.0032
Benzo(a)pyrene	<0.0016	<0.0016	<0.0032
Benzo(b)fluoranthene	<0.0016	<0.0016	<0.0032
Benzo(ghi)perylene	<0.0016	<0.0016	<0.0032
Benzo(k)fluoranthene	<0.0016	<0.0016	<0.0032
Chrysene	<0.0016	<0.0016	<0.0032
Dibenzo(a,h)anthracene	<0.0016	<0.0016	<0.0032
Fluoranthene	<0.0016	<0.0016	<0.0032
Fluorene	<0.0016	0.0032	0.0049
Ideno(1,2,3-cd)pyrene	<0.0016	<0.0016	<0.0032
Napthalene	<0.0016	0.0055	0.0071
Phenanthrene	<0.0016	0.0117	0.0133
Pyrene	<0.0016	<0.0016	<0.0032

Sample Number: Air-005
Sample Date: December 1, 1990
Units: Micrograms/cubic meter

	Filter	Adsorbent	Total
Acenaphthene	<0.0016	0.0019	0.0035
Acenaphylene	<0.0016	0.0019	0.0035
Anthracene	<0.0016	0.0019	0.0035
Benzo(a) anthracene	<0.0016	<0.0016	<0.0032
Benzo(a) pyrene	<0.0016	<0.0016	<0.0032
Benzo(b) fluoranthene	0.0016	<0.0016	0.0032
Benzo(ghi) perylene	<0.0016	<0.0016	<0.0032
Benzo(k) fluoranthene	<0.0016	<0.0016	<0.0032
Chrysene	<0.0016	<0.0016	<0.0032
Dibenzo(a,h) anthracene	<0.0016	<0.0016	<0.0032
Fluoranthene	<0.0016	0.0042	0.0058
Fluorene	<0.0016	0.0077	0.0093
Ideno(1,2,3-cd) pyrene	<0.0016	<0.0016	<0.0032
Napthalene	<0.0016	0.0042	0.0058
Phenanthrene	<0.0016	0.0179	0.0195
Pyrene	<0.0016	0.0029	0.0045

Sample Number: Air-006
Sample Date: December 7, 1990
Units: Micrograms/cubic meters

	Filter	Adsorbent	Total
Acenaphthene	<0.0016	<0.0016	<0.0032
Acenaphylene	<0.0016	<0.0016	<0.0032
Anthracene	<0.0016	<0.0016	<0.0032
Benzo(a) anthracene	<0.0016	<0.0016	<0.0032
Benzo(a) pyrene	<0.0016	<0.0016	<0.0032
Benzo(b) fluoranthene	<0.0016	<0.0016	<0.0032
Benzo(ghi) perylene	<0.0016	<0.0016	<0.0032
Benzo(k) fluoranthene	<0.0016	<0.0016	<0.0032
Chrysene	<0.0016	<0.0016	<0.0032
Dibenzo(a,h) anthracene	<0.0016	<0.0016	<0.0032
Fluoranthene	<0.0016	0.0019	0.0035
Fluorene	<0.0016	0.0047	0.0063
Ideno(1,2,3-cd) pyrene	<0.0016	<0.0016	<0.0032
Napthalene	<0.0016	0.0032	0.0047
Phenanthrene	<0.0016	0.0104	0.0120
Pyrene	<0.0016	<0.0016	<0.0032

Sample Number: Air-007
Sample Date: December 14, 1990
Units: Micrograms/cubic meters

	Filter	Adsorbent	Total
Acenaphthene	<0.0015	0.0024	0.0039
Acenaphylene	<0.0015	<0.0015	<0.0030
Anthracene	<0.0015	0.0018	0.0033
Benzo(a)anthracene	<0.0015	<0.0015	<0.0030
Benzo(a)pyrene	<0.0015	<0.0015	<0.0030
Benzo(b)fluoranthene	0.0024	<0.0015	0.0039
Benzo(ghi)perylene	<0.0015	<0.0015	<0.0030
Benzo(k)fluoranthene	<0.0015	<0.0015	<0.0030
Chrysene	0.0015	<0.0015	0.0030
Dibenzo(a,h)anthracene	<0.0015	<0.0015	<0.0030
Fluoranthene	0.0018	0.0060	0.0079
Fluorene	<0.0015	0.0076	<0.0091
Ideno(1,2,3-cd)pyrene	<0.0015	<0.0015	<0.0030
Napthalene	<0.0015	0.0036	0.0051
Phenanthrene	<0.0015	0.0209	0.0224
Pyrene	0.0015	0.0042	0.0057

Metals Data

(Appendix A)



November 19, 1990

Sym.	Element	Upwind	Downwind
Al	Aluminum	0:0000	0.0000
P	Phosphorus	0.0000	0.0000
S	Sulphur	0.2057	0.0539
Cl	Chlorine	0.0000	0.0000
K	Potassium	0.5032	0.4190
Ca	Calcium	1.421	1.357
Ti	Titanium	0.0576	0.0533
V	Vanadium	0.0028	0.0000
Cr	Chromium	0.0000	0.0000
Mn	Manganese	0.0112	0.0037
Fe	Iron	0.5093	0.2305
Ni	Nickel	0.0000	0.0000
Cu	Copper	0.0056	0.0072
Zn	Zinc	0.0000	0.0000
Ga	Gallium	0.0000	0.0000
Ge	Germanium	0.0007	0.0010
As	Arsenic	0.0017	0.0055
Se	Selenium	0.0000	0.0000
Br	Bromine	0.0051	0.0007
Rb	Rubidium	0.0030	0.0013
Sr	Strontium	0.0096	0.0095
Y	Yttrium	0.0043	0.0000
Zr	Zirconium	0.0240	0.0100
Mo	Molybdenum	0.1022	0.1144
Pd	Palladium	0.0000	0.0023
Ag	Silver	0.0000	0.0000
Cd	Cadmium	0.0000	0.0000
In	Indium	0.0000	0.0000
Sn	Tin	0.0246	0.0312
Sb	Antimony	0.0566	0.0526
Ba	Barium	0.0099	0.0000
La	Lanthanum	0.2403	0.0000
Hg	Mercury	0.0000	0.0000
Pb	Lead	0.0041	0.0000

Units: Micrograms/cubic meter

November 25, 1990

Sym.	Element	Upwind	Downwind
Al	Aluminum	0.0000	0.0000
P	Phosphorus	0.0000	0.0000
S	Sulphur	0.0902	0.0046
Cl	Chlorine	0.0000	0.2265
K	Potassium	0.3673	0.5528
Ca	Calcium	1.415	1.389
Ti	Titanium	0.0553	0.0588
V	Vanadium	0.0000	0.0000
Cr	Chromium	0.0014	0.0000
Mn	Manganese	0.0053	0.0058
Fe	Iron	0.4747	0.3455
Ni	Nickel	0.0000	0.0000
Cu	Copper	0.0029	0.0133
Zn	Zinc	0.0000	0.0000
Ga	Gallium	0.0000	0.0000
Ge	Germanium	0.0020	0.0018
As	Arsenic	0.0000	0.0146
Se	Selenium	0.0012	0.0000
Br	Bromine	0.0035	0.0418
Rb	Rubidium	0.0077	0.0083
Sr	Strontium	0.0154	0.0186
Y	Yttrium	0.0000	0.0014
Zr	Zirconium	0.0211	0.0185
Mo	Molybdenum	0.1098	0.1077
Pd	Palladium	0.0125	0.0000
Ag	Silver	0.0068	0.0025
Cd	Cadmium	0.0000	0.0154
In	Indium	0.0000	0.0000
Sn	Tin	0.0000	0.0141
Sb	Antimony	0.0000	0.0302
Ba	Barium	0.0000	0.0000
La	Lanthanum	0.3178	0.0000
Hg	Mercury	0.0000	0.0000
Pb	Lead	0.0075	0.1190

Units: Micrograms/cubic meter

December 1, 1990

Sym.	Element	Upwind	Downwind
Al	Aluminum	0.0000	0.0000
P	Phosphorus	0.0000	0.0000
S	Sulphur	0.1428	0.0165
Cl	Chlorine	0.0000	0.0000
K	Potassium	0.3560	0.2837
Ca	Calcium	1.378	0.9692
Ti	Titanium	0.0555	0.0369
V	Vanadium	0.0000	0.0000
Cr	Chromium	0.0001	0.0000
Mn	Manganese	0.0061	0.0045
Fe	Iron	0.4609	0.0950
Ni	Nickel	0.0000	0.0000
Cu	Copper	0.0037	0.0018
Zn	Zinc	0.0000	0.0000
Ga	Gallium	0.0000	0.0000
Ge	Germanium	0.0000	0.0005
As	Arsenic	0.0028	0.0019
Se	Selenium	0.0000	0.0000
Br	Bromine	0.0014	0.0030
Rb	Rubidium	0.0032	0.0000
Sr	Strontium	0.0176	0.0136
Y	Yttrium	0.0037	0.0040
Zr	Zirconium	0.0135	0.0150
Mo	Molybdenum	0.0957	0.0998
Pd	Palladium	0.0000	0.0067
Ag	Silver	0.0201	0.0000
Cd	Cadmium	0.0375	0.0028
In	Indium	0.0411	0.0603
Sn	Tin	0.0108	0.0469
Sb	Antimony	0.0477	0.0000
Ba	Barium	0.0479	0.0000
La	Lanthanum	0.4533	0.0000
Hg	Mercury	0.0000	0.0000
Pb	Lead	0.0000	0.0322

Units: Micrograms/cubic meter

December 7, 1990

Sym.	Element	Upwind	Downwind
Al	Aluminum	0.0000	0.0000
P	Phosphorus	0.0000	0.0000
S	Sulphur	0.0000	0.0000
Cl	Chlorine	0.0000	0.0000
K	Potassium	0.3319	0.3044
Ca	Calcium	1.271	1.120
Ti	Titanium	0.0375	0.0388
V	Vanadium	0.0008	0.0049
Cr	Chromium	0.0000	0.0000
Mn	Manganese	0.0064	0.0025
Fe	Iron	0.3530	0.1528
Ni	Nickel	0.0000	0.0000
Cu	Copper	0.0055	0.0017
Zn	Zinc	0.0000	0.0000
Ga	Gallium	0.0000	0.0000
Ge	Germanium	0.0017	0.0015
As	Arsenic	0.0025	0.0000
Se	Selenium	0.0008	0.0000
Br	Bromine	0.0000	0.0002
Rb	Rubidium	0.0048	0.0091
Sr	Strontium	0.0132	0.0155
Y	Yttrium	0.0030	0.0000
Zr	Zirconium	0.0097	0.0095
Mo	Molybdenum	0.1064	0.0974
Pd	Palladium	0.0106	0.0000
Ag	Silver	0.0000	0.0097
Cd	Cadmium	0.0000	0.0436
In	Indium	0.0000	0.0000
Sn	Tin	0.0000	0.0000
Sb	Antimony	0.0000	0.0224
Ba	Barium	0.0000	0.0904
La	Lanthanum	0.0000	0.4776
Hg	Mercury	0.0000	0.0000
Pb	Lead	0.0000	0.0042

Units: Micrograms/cubic meter

December 14, 1990

Sym.	Element	Upwind	Downwind
Al	Aluminum	0.0000	0.0000
P	Phosphorus	0.0000	0.0000
S	Sulphur	0.0632	0.0000
Cl	Chlorine	0.0000	0.8172
K	Potassium	0.3298	0.6669
Ca	Calcium	1.296	1.265
Ti	Titanium	0.0329	0.0500
V	Vanadium	0.0016	0.0046
Cr	Chromium	0.0000	0.0000
Mn	Manganese	0.0013	0.0012
Fe	Iron	0.1334	0.0742
Ni	Nickel	0.0000	0.0000
Cu	Copper	0.0006	0.0000
Zn	Zinc	0.0000	0.5333
Ga	Gallium	0.0000	0.0000
Ge	Germanium	0.0000	0.0000
As	Arsenic	0.0000	0.0122
Se	Selenium	0.0000	0.0000
Br	Bromine	0.0000	0.0297
Rb	Rubidium	0.0002	0.0016
Sr	Strontium	0.0147	0.0098
Y	Yttrium	0.0060	0.0000
Zr	Zirconium	0.0126	0.0232
Mo	Molybdenum	0.1152	0.1057
Pd	Palladium	0.0368	0.0084
Ag	Silver	0.0000	0.0000
Cd	Cadmium	0.0000	0.0408
In	Indium	0.0000	0.0162
Sn	Tin	0.0000	0.0391
Sb	Antimony	0.0000	0.0000
Ba	Barium	0.0000	0.0000
La	Lanthanum	0.0000	0.0367
Hg	Mercury	0.0000	0.0000
Pb	Lead	0.0080	0.2640

Units: Micrograms/cubic meter

December 19, 1990

Sym.	Element	Upwind	Downwind
Al	Aluminum	0.0000	0.0000
P	Phosphorus	0.0000	0.0000
S	Sulphur	0.2765	0.1788
Cl	Chlorine	0.0000	0.0000
K	Potassium	0.4470	0.2853
Ca	Calcium	1.505	1.235
Ti	Titanium	0.0610	0.0384
V	Vanadium	0.0018	0.0000
Cr	Chromium	0.0000	0.0000
Mn	Manganese	0.0091	0.0031
Fe	Iron	0.5046	0.0699
Ni	Nickel	0.0000	0.0000
Cu	Copper	0.0051	0.0003
Zn	Zinc	0.0000	0.0000
Ga	Gallium	0.0000	0.0000
Ge	Germanium	0.0000	0.0005
As	Arsenic	0.0015	0.0000
Se	Selenium	0.0014	0.0000
Br	Bromine	0.0058	0.0014
Rb	Rubidium	0.0000	0.0012
Sr	Strontium	0.0113	0.0085
Y	Yttrium	0.0000	0.0039
Zr	Zirconium	0.0256	0.0278
Mo	Molybdenum	0.1087	0.1091
Pd	Palladium	0.0322	0.0000
Ag	Silver	0.0309	0.0122
Cd	Cadmium	0.0126	0.0387
In	Indium	0.0520	0.0000
Sn	Tin	0.0723	0.0000
Sb	Antimony	0.0201	0.0161
Ba	Barium	0.0000	0.0000
La	Lanthanum	0.1148	0.0000
Hg	Mercury	0.0000	0.0000
Pb	Lead	0.0104	0.0000

Units: Micrograms/cubic meter

A P P E N D I X B

Quality Control & Quality Assurance



Calibration

(Appendix B)



B I S O N E N G I N E E R I N G I N C

Helena, Montana

Total Suspended Particulate - Calibration

Envirocon

Calibrated by Scott F & Dan M Location Livingston

Date November 8, 1990 Sampler # 3 - Downwind

Calibration Equation: $Q_r = .49134 (dP)^{.49610}$

Run	Plate No.	P1 (left)	P2 (right)	dP (total)	TR	Qr *	Qr +
1	18	3.9	3.8	7.7	46	1.353	1.346
2	13	3.0	2.85	5.85	41	1.180	1.165
3	10	2.5	2.35	4.85	39	1.075	1.092
4	7	1.75	1.55	3.3	34	0.888	0.911
5	5	1.15	0.95	2.10	28	0.710	0.693

*

Qr = flow rate by Orifice equation

+

Qr = flow rate from transducer regression equation

Results--

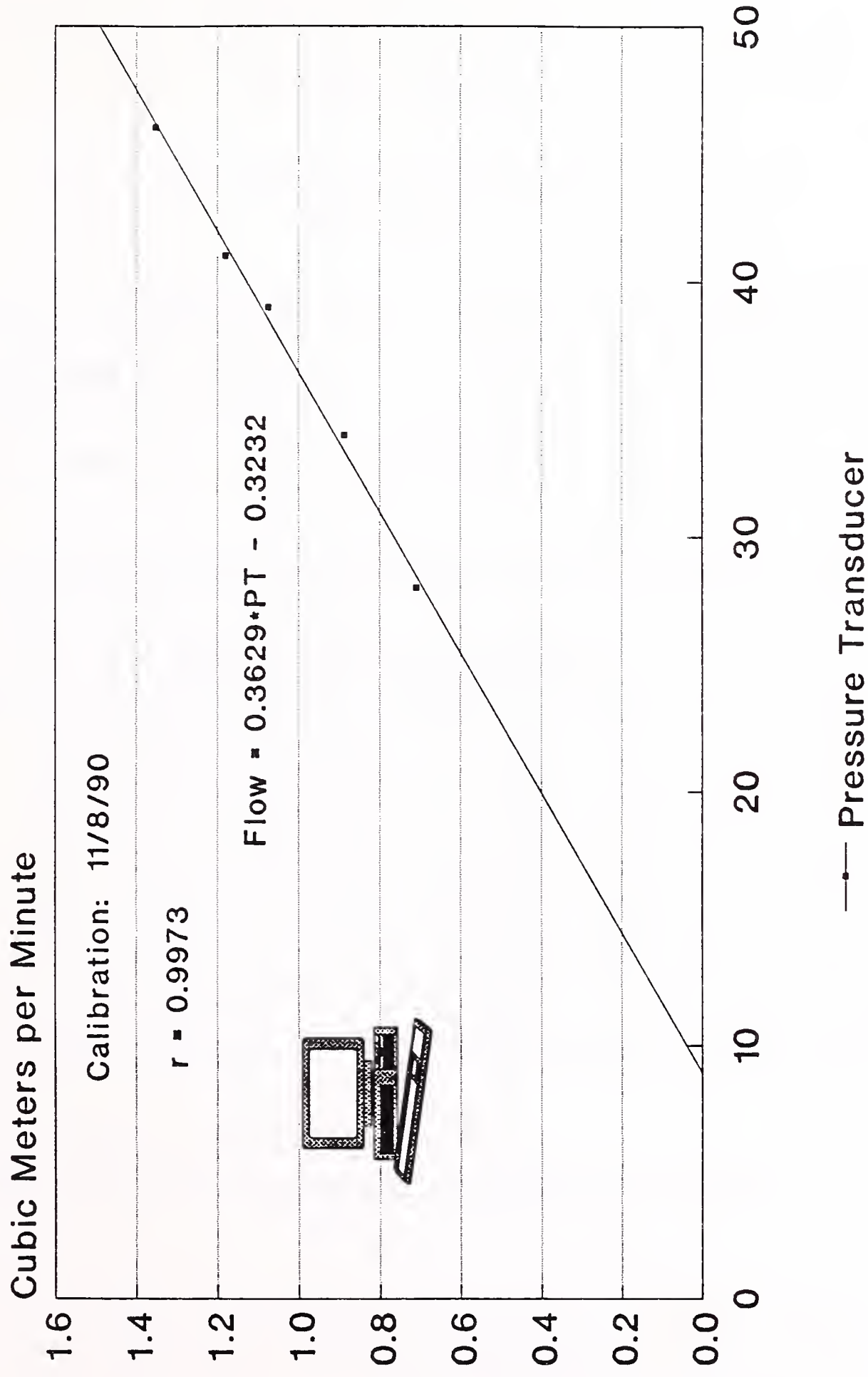
Slope = .03629 Intercept = -0.3232 Corr. Coeff. = 0.9973

$Q_r = a(TR) + b =$.03629 (TR) + -0.3232



TSP Calibration Curve

Downwind Monitor



Envirocon - Livingston

B I S O N E N G I N E E R I N G I N C

Helena, Montana

Puff Sampler Calibration

Envirocon

Calibrated by Dan M. & Hal R. Location Livingston - Downwind

Date November 8, 1990 Sampler # Downwind #1624

Calibration Equation: $Q_r = .114375(dP)^{.5} - 0.00849$

Run	Gauge	P1 (left)	P2 (right)	dP (total)	TR	Qr [*]	Qr ⁺
1	70	2.75	3.35	6.10	70	.2740	.2770
2	60	2.40	2.90	5.30	60	.2548	.2533
3	50	2.00	2.45	4.45	50	.2328	.2296
4	40	1.55	2.00	3.55	40	.2070	.2059
5	30	1.20	1.50	2.70	30	.1794	.1822

*

Qr = flow rate by Orifice equation

+

Qr = flow rate from transducer regression equation

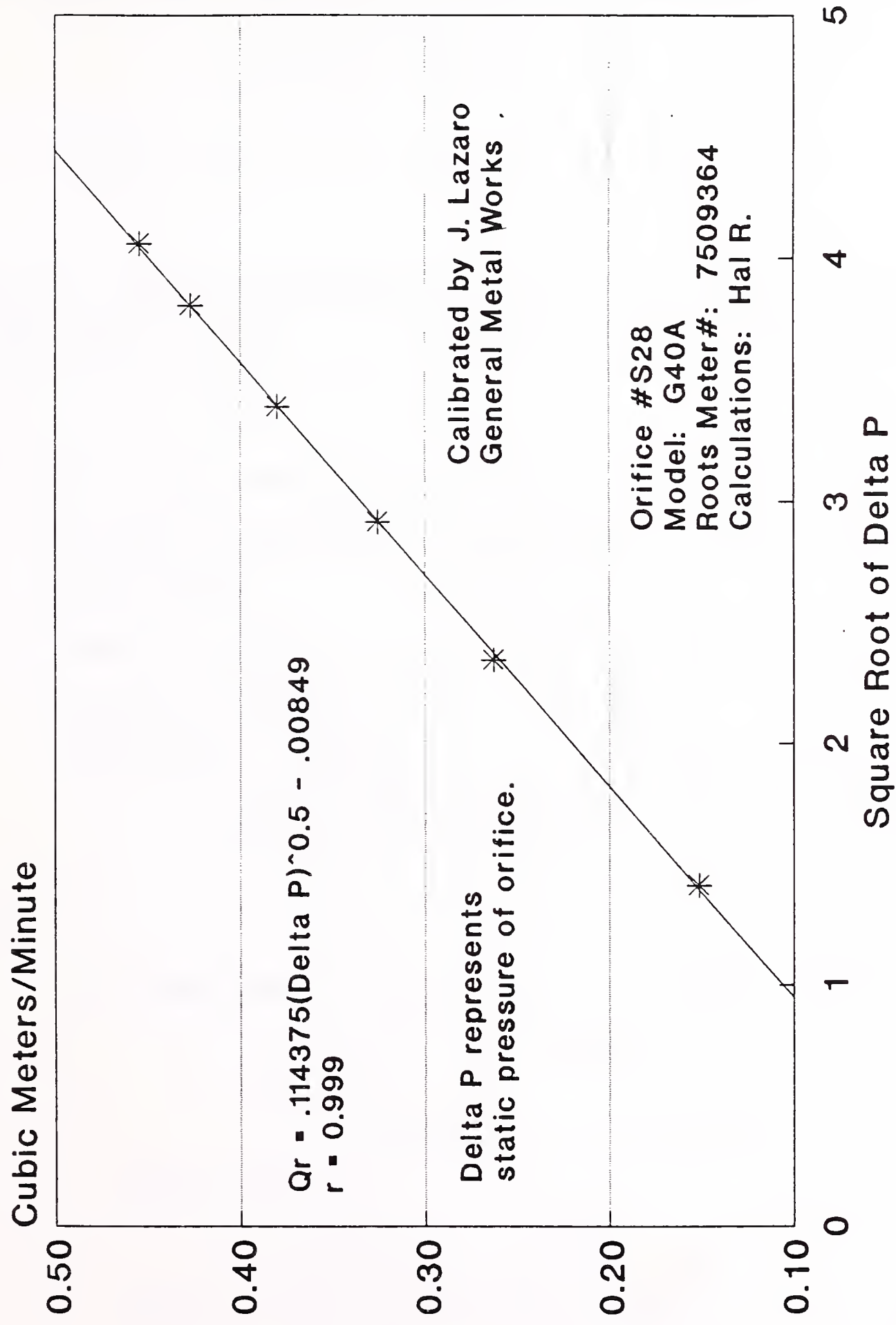
Results--

Slope = 0.00237 Intercept = 0.1111 Corr. Coeff. = 0.999

$Q_r = a(\text{Gauge}) + b = \underline{0.00237} (\text{TR}) + \underline{0.1111}$



Puff Orifice Calibration Delta P vs Flow (Qr)



B I S O N E N G I N E E R I N G I N C

Helena, Montana

PM-10 Calibration - Wedding Assoc.

Calibrated by Bengt Nordenson Location Livingston
Date November 8, 1990 Sampler # 2 - Downwind

Look-up :

20" U-Tube Manometer: 20.4 " Water = delta
Barometric Pressure : 25.28 " Mercury = P0
Temperature: 43 F
P1/P0 = 0.941 {P1=P0 - delta/13.6
Look-up = 39.166 = Look-ACFM
Look-SCFM = 35.332 (std ft³/min)
= ACFM[P0*298]/29.92*Tk] Tk=temp degrees K

Orifice:

10 " Manometer 4.4 " (Clean Filter)

$$Q = .49134 \text{ (dP)} \quad .49610$$
$$= \underline{1.025} \quad (\text{m}^3/\text{min})$$

$$Q_{\text{cfm}} = Q * 35.314$$
$$= \underline{36.186} \quad (\text{acfm})_r$$
$$Q_{\text{scfm}} = Q_{\text{cfm}} [(P_0 * 298) / (29.92 * T_k)]^{0.5}$$
$$= \underline{34.370}$$

% Difference: 2.8 %

Adjustment: N/A (if necessary)

Clean Filter Transducer: _____



B I S O N E N G I N E E R I N G I N C

Helena, Montana

PM-10 Calibration - Wedding Assoc.

Calibrated by Bengt Nordenson Location Livingston
Date November 8, 1990 Sampler # 1 - Upwind

Look-up :

20" U-Tube Manometer: 20.95 " Water = delta
Barometric Pressure : 25.37 " Mercury = P0
Temperature: 46 F
P1/P0 = 0.939 {P1=P0 - delta/13.6
Look-up = 39.446 = Look-ACFM
Look-SCFM = 35.499 (std ft³/min)
= ACFM[P0*298]/29.92*Tk] Tk=temp degrees K

Orifice:

10 " Manometer 4.35 " (Clean Filter)

$$\begin{aligned} Q &= .49134 \text{ (dP)} \\ &= \underline{1.019} \text{ (m}^3\text{/min)} \\ Q_{cfm} &= Q * 35.314 \\ &= \underline{35.982} \text{ (acfm)} \\ Q_{scfm} &= Q_{cfm} [(P0 * 298) / (29.92 * Tk)]^{0.5} \\ &= \underline{34.134} \end{aligned}$$

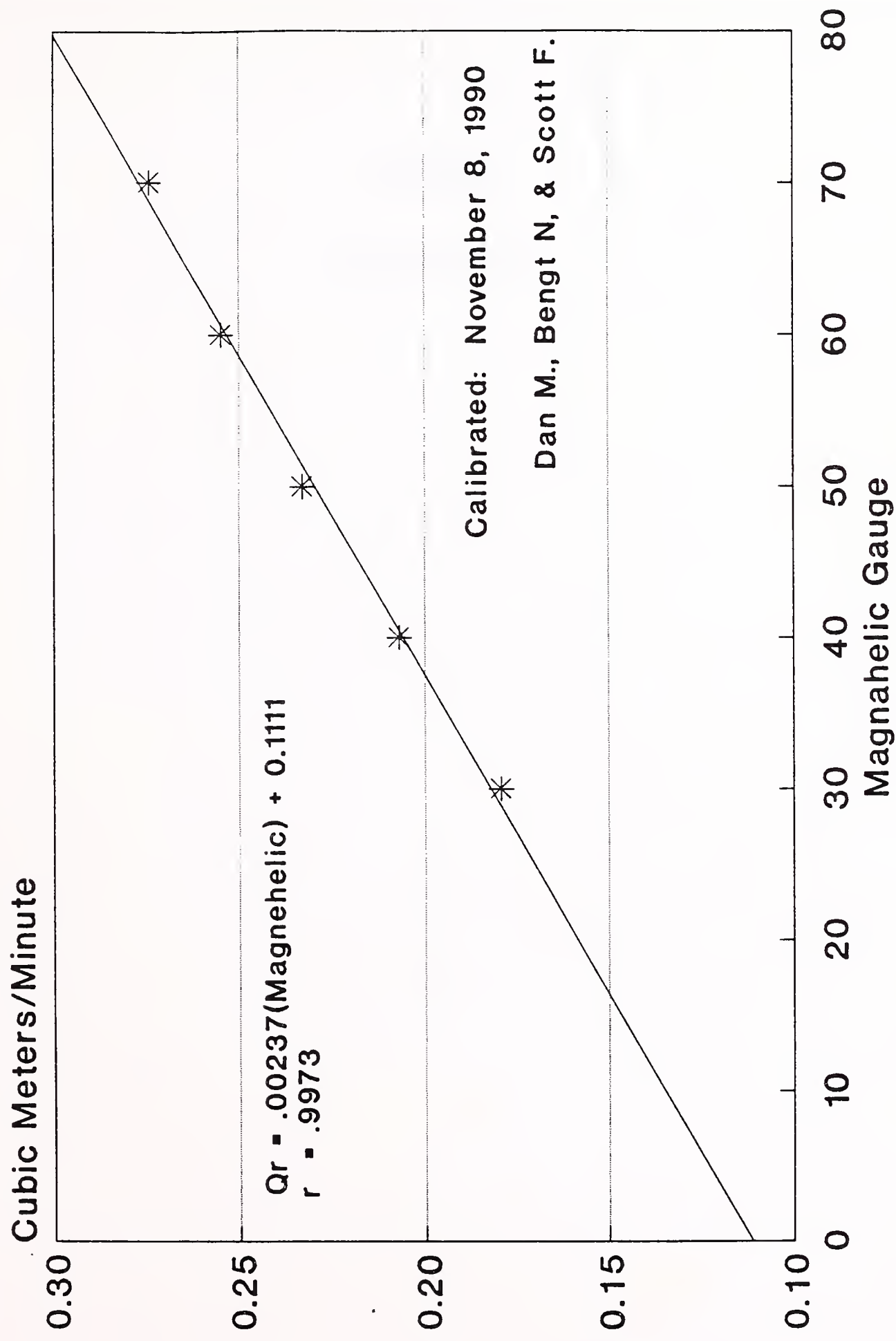
% Difference: 4.0 %

Adjustment: N/A (if necessary)

Clean Filter Transducer: _____



Puff Sampler Calibration Magnehelic vs Flow (Qr)



Audits

(Appendix B)



Helena, Montana

- Wedding Assoc.

Location Livingston

Sampler # 2 - Downwind

$$= \text{ACFM}[P_0 \cdot 298] / 29.92 \cdot T_k \quad T_k = \text{temp degrees K}$$

% Difference: -2.8 % % (from 40 ACFM)



Helena, Montana

B I S O N E N G I N E E R I N G I N C

Helena, Montana

Total Suspended Particulate - Audit

Audited by Hal Robbins Company Envirocon

Date Nov. 9, 1990 Project Livingston Railyard

.48645

Audit Equation: $Q_r = .62283 (dP)$

Sample #	Plate No.	P1 (left)	P2 (right)	dP (total)	TR	Qr *	Qr +
3	18	2.45	2.20	4.65	46	1.315	1.346
	18						
	18						
	18						
	18						

*
Qr = flow rate by Audit Equation

+
Qr = flow rate from previous calibration equation

Results:

Sampler #	% Difference
<u>3</u>	<u>2.3</u> %
<u> </u>	<u> </u> %
<u> </u>	<u> </u> %
<u> </u>	<u> </u> %
<u> </u>	<u> </u> %



B I S O N E N G I N E E R I N G I N C

Helena, Montana

Meteorological Monitoring System Met One

Audit

Performed by H Robbins, J Dartman Location Livingston

Date November 8, 1990 Serial #: Met One

East/West Theodolite Position

Vertical Alignmet of Wind Speed: OK

Vertical Alignmet of Wind Direction: OK

Cross Arm East/West: OK

Indicated North: 1.5 degrees

North/South Theodolite Position

Vertical Alignmet of Wind Speed: OK

Vertical Alignmet of Wind Direction: OK

Cross Arm Horizontal: OK

Wind Vane

	DAS	Strip Chart
0/360	1.5	---
90	90.2	---
180	180.8	---
270	270.5	---

Wind Speed

	0	0.0	--
(Sync. Motor)	36.5	36.1	--
(Sync. Motor)	9.0	9.7	--

Comments: NBS Temp = 6.8C DAS Temp = 7.0 C
Cup Torque = 0.2 g-cm Vane Torque = 1.5 g-cm



BISON ENGINEERING INC
Helena, Montana

Meteorological Audit Report

Railyard Project

Livingston, Montana

An audit of the meteorological system was conducted on November 8, 1990. The system was checked for proper alignment and motion responses, torques, etc.

The sensor height was measured by means of a theodolite and determined to be 10 meters (+- 1/2). The vertical alignment and horizontal crossarms were also checked using a theodolite. The alignment was acceptable.

The theodolite was sited directly south of the tower in order to determine the alignment noted above. The true south location was determined using the position of the sun relative to the latitude and longitude and time of day. A program called "ALMANAC" was used to determine the sun's angle any particular time of the day. It is estimated that this locations was determined to be within 0.5 degrees of true south.

Access to the tower instruments was gained using a man-lift. The data acquisition output (WTC ICIS-3) was checked against the four cardinal compass directions. Directions other than north and south were estimated using dead reckoning and a comparison with an observer on the ground using the theodolite. (West and East vane directions had the largest angular change when viewed through the theodolite). The results are repeated below from the audit data sheet at the end of this section.

North	1.5 degrees	(DAS)
East	90.2 degrees	(DAS)
South	180.8 degrees	(DAS)
West	270.5 degrees	(DAS).

It was the opinion of the auditor that the system could be slightly adjusted to improve data quality. This was discussed with the on-site operator. The system was adjusted after the audit was completed. The results of this audit reflect the system as it was observed at the time.

Additionally, an audit of the wind anemometer was conducted. A synchronous motor was used in order to generate a known rpm (Climatronics Model 101252-1 S/N 60). The wind cups were removed



prior to installing the motor in order to prevent any drag on the system. The motor produces 600 rpm which translates to a theoretical wind speed of 36.5 miles per hour. The actual DAS response was 36.1 miles per hour. A 4:1 gearing ratio was used to generate a second "known" wind speed of 9.1 mph. The DAS response was 9.7. The anemometer shaft was also held steady to determine the zero wind speed output. The DAS responded with a value of 0.0 mph.

The anemometer starting torque was checked with a Waters Torque Watch. The starting torque was observed to be less than .2 gram-cm. The threshold torque for 0.5 meters/sec is about .3 gram-cm. The starting torque for the wind direction was checked with an R.M. Young torque disk and the torque watch. The measured torque was 1.5 gram-cm. The starting threshold is about 3 gram-cm. Thus, the two starting torques were within proper specifications.

Finally, the met system wind temperature was checked. The temperature according to an NBS traceable thermometer (VWR Digital Thermometer: Serial # 639156). The actual temperature was 6.8 C with a DAS response of 7.0.

The theodolite used for this audit was a Leitz Model TM-6 7100 obtained from Selby's in Helena. The unit was serviced immediately prior to use.



Data Recovery

(Appendix B)



PARTICULATE DATA RECOVERY

Railyard Project - Livingston
1 9 9 0

<u>Variable</u>	<u>Total Periods</u>	<u>Total Measurements</u>	<u>Percentage Recovered</u>
PM10 Particulate			
Site # 1 - Upwind -----			
November	3	3	100%
December	6	6	100%
Quarter	9	9	100%
Year-to-Date	9	9	100%
Site # 2 - Downwind -----			
November	3	3	100%
December	6	6	100%
Quarter	9	9	100%
Year-to-Date	9	9	100%
TSP Particulate			
Site # 2 - Downwind -----			
November	2	3	67%
December	4	6	67%
Quarter	6	9	67%
Year-to-Date	6	9	67%



METEOROLOGICAL DATA RECOVERY

Railyard Project - Livingston

1 9 9 0

<u>Variable</u>	<u>Total Periods</u>	<u>Total Measurements</u>	<u>Percentage Recovered</u>
<i>Wind Speed</i> -----			
November	465	465	100%
December	744	616	83%
Quarter	1,209	1,081	89%
Period to Date	1,209	1,081	89%
<i>Wind Direction</i> -----			
November	465	465	100%
December	744	616	83%
Quarter	1,209	1,081	89%
Period to Date	1,209	1,081	89%
<i>Temperature</i> -----			
November	465	465	100%
December	744	616	83%
Quarter	1,209	1,081	89%
Period to Date	1,209	1,081	89%



PM10 Precision

(Appendix B)



BISON ENGINEERING INC
Helena, Montana

Co-located PM10 Air Sampler Precision Analysis

Rosebud Energy

Colstrip, Montana

4th QUARTER-1990

<u>Date</u>	<u>Reporting Sampler Conc. (ug/M3)</u>	<u>Co-located Sampler Conc. (ug/M3)</u>	<u>D(%)</u>
90 10 02	10	10	0.0
90 10 08	5	6	18.2
90 10 14	11	11	0.0
90 10 20	5	6	18.2
90 10 26	25	29	14.8
90 11 01	6	3	-66.7
90 11 07	7	8	13.3
90 11 13	9	12	28.6
90 11 19	14	14	0.0
90 11 25	14	15	6.9
90 12 07	7	7	0.0
90 12 13	9	1	-160.0
90 12 19	7	6	-15.4
90 12 25	7	7	0.0
90 12 31	7	5	-33.3

$$D\% = \frac{(Y_i - X_i)}{(Y_i + X_i)/2} \times 100$$

No. Samples = 15.0

Average D = -11.7

Std. Dev. D = 47.3

Probability Limits:

XBAR - 1.96 SD/SQRT(2) = -77.26

XBAR + 1.96 SD/SQRT(2) = 53.86



PNA - Laboratory Quality Control

(Appendix B)





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FAX (406) 252-6069 • 1-800-873-5227

ENVIROCON
PO BOX 1154
LIVINGSTON MT. 59047

Air Analysis
PUF Adsorbent

PROJECT: Livingston / BN

LAB NO.	90-34881
SAMPLE IDENTIFICATION	140101-Air-007
SAMPLE SUBMITTED	12/26/90
DATE REPORTED	01/18/91
SAMPLE DATE	12/18/90
SAMPLE TIME	1100

PARAMETER	ug/filter medium
Acenaphthene	0.8
Acenaphthylene	<0.5
Anthracene	0.6
Benzo(a)anthracene	<0.5
Benzo(a)pyrene	<0.5
Benzo(b)fluoranthene	<0.5
Benzo(ghi)perylene	<0.5
Benzo(k)fluoranthene	<0.5
Chrysene	<0.5
Dibenzo(a,h)anthracene	<0.5
Fluoranthene	2.0
Fluorene	2.5
Ideno(1,2,3-cd)pyrene	<0.5
Naphthalene	1.2
Phenanthrene	6.9
Pyrene	1.4

REMARKS: Analysis by GC/MS
procedures outlined in
EPA Method T013.

Q.A. Review: _____

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ENVIROCON, Inc.
Livingston, Mt.



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ENVIROCON, Inc.
Livingston, MT

ENVIROCON
PO BOX 1154
LIVINGSTON MT 59047

SEMIVOLATILE SURROGATE RECOVERY

PROJECT: Livingston/BN

SAMPLE NO.	S1 (NBZ) #	S2 (FBP) #	S3 (TPH) #
90-34879 Filter	84	83	80
90-34879 PUF	83	91	98
90-34880 Filter	94	90	91
90-34880 PUF	80	85	91
90-34881 Filter	87	87	89
90-34881 PUF	43	105	108

S1 (NBZ) = Nitrobenzene-d5
S2 (FBP) = 2-Fluorobiphenyl
S3 (TPH) = Terphenyl-d14

QC LIMITS
35-114
43-116
33-141

Column to be used to flag recovery values with an asterisk

* Values outside of contract required QC limits

Q.A. Review: _____



ENERGY LABORATORIES, INC.

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JAN 21 1991

ENVIROCON, Inc.
Livingston, MT

ENVIROCON
PO BOX 1154
LIVINGSTON MT 59047

EPA QUALITY CONTROL SAMPLE
Polynuclear Aromatics

PUF

PROJECT: Livingston/BN

This EPA Quality Control sample was analyzed with your Lab Nos.
90-34879 thru 90-34881 with the following results:

PARAMETER	True Value, ug/filter medium	P (%)
Acenaphthylene	10	74
Acenaphthene	10	81
Anthracene	10	67
Naphthalene	10	69
Phenanthrene	10	74
Fluoranthene	1.0	106
Benzo(a)anthracene	1.0	101
Benzo(a)pyrene	1.0	87
Benzo(b)fluoranthene	1.0	95
Dibenzo(a,h,)anthracene	1.0	79
Benzo(g,h,i)perylene	1.0	74
Pyrene	1.0	88
Chrysene	1.0	82
Indeno(1,2,3-cd)pyrene	1.0	70
Benzo(k)fluoranthene	0.5	74

P = Percent recovery measured.

Q.A. Review: _____

Metals - Laboratory Quality Control

(Appendix B)



XRF-4

XRF QUALITY ASSURANCE AND CONTROL DATA SUMMARY

CLIENT: BISON ENGINEERING

PERIOD OF ANALYSIS: January 18 through 21, 1991

NEA QUALITY CONTROL STANDARD: QS285

QC STANDARD RESULTS

Element	n	Percent Deviation		
		mean(a)	S.D.	Range
Fe	17	2.0	1.1	5.6

NBS STANDARD REFERENCE MATERIALS: SRM 1832, SRM 1833

Element	n	Certified Value(ug/cm2)	NEA % Dev. from C.V.			NBS % Uncertainty
			mean	S.D.	Range	
Fe	26	13.6 +/- .45	0.45	1.67	0.8	3.3
Cu	26	2.46 +/- .16	1.85	2.67	0.3	6.6
Zn	26	3.88 +/- .23	1.86	1.67	0.3	6.0
Pb	26	16.1 +/- .85	-0.13	1.45	1.0	5.3
Mean(a)			1.01	1.87	0.59	5.30

a. Mean of absolute values

XRF-2

XRF QUALITY ASSURANCE AND CONTROL DATA SUMMARY

CLIENT: BISON ENGINEERING

PERIOD OF ANALYSIS: January 18 through 21, 1991

NEA QUALITY CONTROL STANDARD: QS116

QC STANDARD RESULTS

Element	n	Percent Deviation		
		mean(a)	S.D.	Range
Si	12	1.4	1.5	6.0

NBS STANDARD REFERENCE MATERIALS: SRM 1832, SRM 1833

Element	n	Certified Value(ug/cm2)	NEA % Dev. from C.V.			NBS % Uncertainty
			mean	S.D.	Range	
Al	31	14.6 +/- 1.0	0.20	3.04	12.8	6.7
Si	31	34.8 +/- 1.1	-1.94	2.46	9.4	3.2
Si	31	33.0 +/- 2.1	0.23	2.07	9.0	6.5
K	17	17.3 +/- 1.7	0.52	2.87	13.3	10.0
Ca	17	19.4 +/- 1.3	0.79	1.48	4.6	6.7
Ti	17	12.8 +/- 1.9	1.83	1.93	8.2	14.7
V	17	4.70 +/- .49	-1.36	1.61	5.7	10.4
Mn	17	4.54 +/- .49	-1.39	1.62	6.6	9.2
Fe	17	14.2 +/- .47	0.63	2.68	9.4	3.3
Cu	17	2.43 +/- .16	-0.70	2.70	9.1	6.6
Zn	17	4.01 +/- .24	-1.29	2.83	9.2	6.0
Pb	17	16.7 +/- .89	-1.63	1.79	5.7	5.3
Mean(a)			1.04	2.26	8.6	7.4

a. Mean of absolute values

XRF-5

XRF QUALITY ASSURANCE AND CONTROL DATA SUMMARY

CLIENT: BISON ENGINEERING

PERIOD OF ANALYSIS: January 18 through 21, 1991

NEA QUALITY CONTROL STANDARD: QS288

QC STANDARD RESULTS

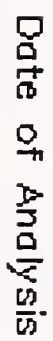
Element	n	Percent Deviation		
		mean(a)	S.D.	Range
Ti	16	1.6	1.3	7.5

NBS STANDARD REFERENCE MATERIALS: SRM 1832, SRM 1833

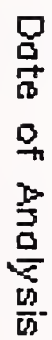
Element	n	Certified Value(ug/cm2)	NEA % Dev. from C.V.			NBS % Uncertainty
			mean	S.D.	Range	
K	16	16.4 +/- 1.6	0.69	2.81	8.3	10.0
Ca	16	20.2 +/- 1.4	0.20	2.11	6.9	6.7
Ti	16	12.1 +/- 1.8	0.03	2.15	7.7	14.7
V	16	4.76 +/- .50	0.71	1.89	6.3	10.4
Mn	16	4.59 +/- .42	2.86	2.43	7.7	9.2
Fe	16	13.6 +/- .45	-0.18	1.84	6.4	3.3
Pb	15	16.1 +/- .85	-0.64	1.72	6.5	5.3
Mean(a)			0.52	2.14	7.12	8.51

a. Mean of absolute values

XRF-4 1991 Iron Condition 1



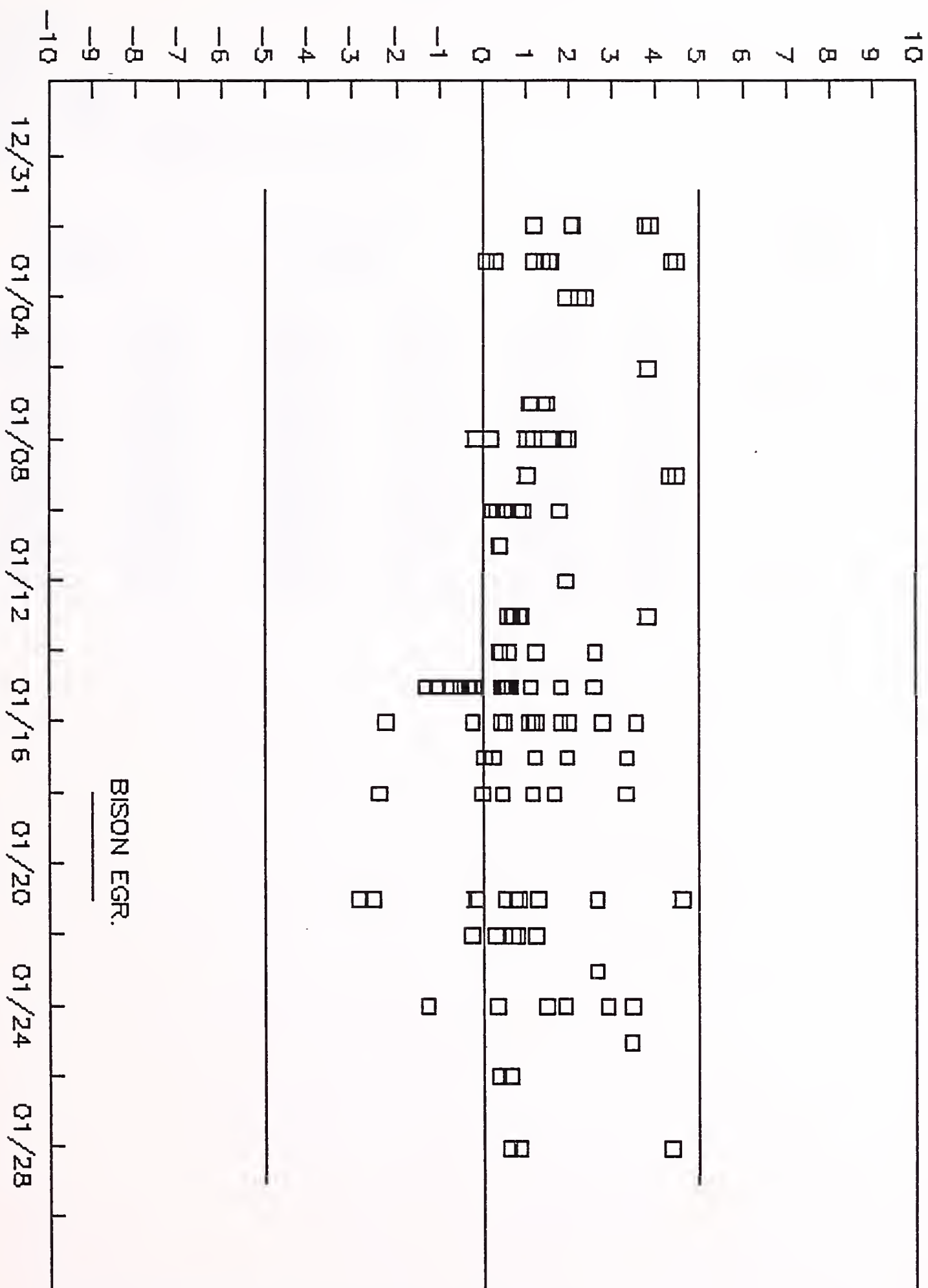
XRF--2 1991 Silicon Condition 2



XRF QUALITY ASSURANCE DATA

XRF-5 1991 Titanium Condition 3

Date of Analysis



REPLICATE REPORT
322/01
PROTOCOL: 4 SA

SAMPLE ID: 09572
PARTICLE SIZE: C
ORIGINAL ID: Q0208
REPLICATE ID: R0208
EXPOSED AREA: 406.00 SQUARE CM
MASS OF DEPOSIT: 0.+- 0. MICROGRAMS

ELEMENT	ORIGINAL UG/CM2		REPLICATE UG/CM2		CHANGE IN UG/CM2	PERCENT ERROR	
V	.0000+-	.0132	.0000+-	.0140	.0000+- .0192		
CR	.0000+-	.0094	.0000+-	.0099	.0000+- .0137		
MN	.0170+-	.0075	.0126+-	.0079	-.0044+- .0109	-25.9+-	64.1
FE	.3611+-	.0518	.5509+-	.0605	.1898+- .0796	52.6+-	22.1
NI	.0000+-	.0089	.0000+-	.0092	.0000+- .0128		
ZN	.0000+-	.0892	.0000+-	.0880	.0000+- .1253		
AS	.0071+-	.0184	.0000+-	.0192	-.0071+- .0266		
CD	.0107+-	.0888	.0000+-	.0901	-.0107+- .1265		
BA	.0000+-	.6023	.3051+-	.6027	.3051+- .8521		
HG	.0000+-	.0133	.0000+-	.0138	.0000+- .0192		
PB	.1223+-	.0315	.1047+-	.0317	-.0176+- .0447	-14.4+-	36.5

REPLICATE REPORT
322/01
PROTOCOL: 4 SA

SAMPLE ID: 09564
PARTICLE SIZE: C
ORIGINAL ID: Q0233
REPLICATE ID: R0233
EXPOSED AREA: 406.00 SQUARE CM
MASS OF DEPOSIT: 0.+- 0. MICROGRAMS

ELEMENT	ORIGINAL UG/CM2		REPLICATE UG/CM2		CHANGE IN UG/CM2		PERCENT ERROR	
V	.0000+-	.0141	.0000+-	.0140	.0000+-	.0199		
CR	.0000+-	.0098	.0381+-	.0115	.0381+-	.0151		
MN	.0115+-	.0079	.0137+-	.0083	.0022+-	.0115		
FE	.2628+-	.0475	.2206+-	.0458	-.0422+-	.0660	-16.1+-	25.1
NI	.0000+-	.0089	.0000+-	.0087	.0000+-	.0124		
ZN	.0000+-	.0773	.0000+-	.0767	.0000+-	.1089		
AS	.0000+-	.0166	.0199+-	.0163	.0199+-	.0233		
CD	.1456+-	.0891	.0000+-	.0888	-.1456+-	.1258		
BA	.0000+-	.5957	.0000+-	.5918	.0000+-	.8397		
HG	.0000+-	.0131	.0000+-	.0131	.0000+-	.0185		
PB	.0000+-	.0302	.0000+-	.0296	.0000+-	.0423		

Client: Bison
Report Date: 1/28/91

Project Number: 322/001
Date Received: 1/18/91

NEA ID: 91-Q235
Site:

Client ID: Blank
Sample Date:

Element	ug/filter
Al	0.0000 +-829.1
P	0.0000 +- 20.18
S	0.0000 +- 48.76
Cl	9.013 +- 29.23
K	496.9 +- 31.83
Ca	1563. +- 81.89
Ti	144.7 +- 10.43
V	0.0000 +- 5.846
Cr	16.73 +- 3.735
Mn	1.015 +- 2.680
Fe	201.1 +- 12.14
Ni	12.83 +- 3.086
Cu	0.0000 +- 2.477
Zn	775.1 +- 39.63
Ga	0.0000 +- 2.761
Ge	0.0000 +- 2.111
As	0.0000 +- 5.359
Se	0.0000 +- 2.314
Br	2.680 +- 2.680
Rb	13.03 +- 3.735
Sr	11.98 +- 4.141
Y	10.60 +- 4.344
Zr	22.33 +- 9.176
Mo	175.3 +- 16.65
Pd	6.252 +- 17.17
Ag	32.85 +- 23.83
Cd	0.0000 +- 29.88
In	0.0000 +- 38.65
Sn	4.791 +- 45.39
Sb	32.60 +- 53.75
Ba	621.6 +-204.9
La	338.3 +-230.7
Hg	0.0000 +- 4.628
Pb	6.131 +- 9.744

Miscellaneous Calculations

(Appendix B)



Puff Sampler Run Day Analysis

Air Volume Calculations

Sample ID #	Date	Time (Minutes)	Temperature (F)	Barometric Pressure (Inches)	Magnehelic	Sampled Volume (M ³)
Air-001	11/10/90	1441.7	54	25.07	44	290.5
Air-002	11/19/90	1414.4	10	25.07	47	306.3
Air-003	11/25/90	1457.1	9	25.30	44	308.8
Air-004	Blank					-----
Air-005	12/ 1/90	1422.2	-5	25.30	46	312.8
Air-006	12/ 7/90	1432.0	3	25.18	48	316.5
Air-007	12/14/90	1436.3	-5	25.00	51	330.9

Orifice Calibration Curve:

$$Q_r = .00237(\text{Magnehelic}) + 0.1111$$

Flow adjusted to SAC.

A P P E N D I X C

Laboratory Analyses



PNA - Laboratory Data

(Appendix C)





ENERGY LABORATORIES, INC.

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PO BOX 1154
LIVINGSTON MT- 59047Air Analysis
Glass Fiber Filter

PUF

PROJECT: Livingston / BN

LAB NO.	90-32933	90-32934
SAMPLE IDENTIFICATION	140101-Air-001	140101-Air-002
SAMPLE SUBMITTED	11/30/90	11/30/90
DATE REPORTED	01/11/91	01/11/91
SAMPLE DATE	11/10/90	11/19/90

Parameter	ug/filter medium	ug/filter medium
Acenaphthene	<0.5	<0.5
Acenaphthylene	<0.5	<0.5
Anthracene	<0.5	<0.5
Benzo(a)anthracene	<0.5	<0.5
Benzo(a)pyrene	<0.5	<0.5
Benzo(b)fluoranthene	<0.5	1.1
Benzo(ghi)perylene	<0.5	<0.5
Benzo(k)fluoranthene	<0.5	<0.5
Chrysene	<0.5	<0.5
Dibenzo(a,h)anthracene	<0.5	<0.5
Fluoranthene	<0.5	<0.5
Fluorene	<0.5	<0.5
Ideno(1,2,3-cd)pyrene	<0.5	<0.5
Naphthalene	<0.5	<0.5
Phenanthrene	<0.5	<0.5
Pyrene	<0.5	<0.5

Remarks: Analysis by GC/MS
procedures outlined in EPA
Method T013.Q.A. Review: *for Shuchis*

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Livingston, Mt.

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ENVIROCON, INC.
Livingston, MTENVIROCON
PO BOX 1154
LIVINGSTON MT 59047Air Analysis
PUF Adsorbent

PROJECT: Livingston / BN

LAB NO.	90-32933	90-32934
SAMPLE IDENTIFICATION	140101-Air-001	140101-Air-002
SAMPLE SUBMITTED	11/30/90	11/30/90
DATE REPORTED	01/11/91	01/11/91
SAMPLE DATE	11/10/90	11/19/90

Parameter	ug/filter medium	ug/filter medium
Acenaphthene	0.7	0.9
Acenaphthylene	<0.5	<0.5
Anthracene	<0.5	0.6
Benzo(a)anthracene	<0.5	<0.5
Benzo(a)pyrene	<0.5	<0.5
Benzo(b)fluoranthene	<0.5	<0.5
Benzo(ghi)perylene	<0.5	<0.5
Benzo(k)fluoranthene	<0.5	<0.5
Chrysene	<0.5	<0.5
Dibenzo(a,h)anthracene	<0.5	<0.5
Fluoranthene	0.5	1.7
Fluorene	1.3	2.5
Ideno(1,2,3-cd)pyrene	<0.5	<0.5
Naphthalene	0.8	0.8
Phenanthrene	5.3	8.3
Pyrene	<0.5	1.4

Remarks: Analysis by GC/MS
procedures outlined in EPA
Method T013.Q.A. Review: *AS*



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ENVIROCON, Inc.
Livingston, MTENVIROCON
PO BOX 1154
LIVINGSTON MT- 59047Air Analysis
Glass Fiber Filter PUF

PROJECT: Livingston / BN

LAB NO.	90-32935	90-32936
SAMPLE IDENTIFICATION	140101-Air-003	140101-Air-004
SAMPLE SUBMITTED	11/30/90	11/30/90
DATE REPORTED	01/11/91	01/11/91
SAMPLE DATE	11/25/90	11/28/90

Parameter	ug/filter medium	ug/filter medium
Acenaphthene	<0.5	<0.5
Acenaphthylene	<0.5	<0.5
Anthracene	<0.5	<0.5
Benzo(a)anthracene	<0.5	<0.5
Benzo(a)pyrene	<0.5	<0.5
Benzo(b)fluoranthene	<0.5	<0.5
Benzo(ghi)perylene	<0.5	<0.5
Benzo(k)fluoranthene	<0.5	<0.5
Chrysene	<0.5	<0.5
Dibenzo(a,h)anthracene	<0.5	<0.5
Fluoranthene	<0.5	<0.5
Fluorene	<0.5	<0.5
Ideno(1,2,3-cd)pyrene	<0.5	<0.5
Naphthalene	<0.5	0.7
Phenanthrene	<0.5	<0.5
Pyrene	<0.5	<0.5

Remarks: Analysis by GC/MS
procedures outlined in EPA
Method T013.Q.A. Review:

ENVIROCON
PO BOX 1154
LIVINGSTON MT 59047Air Analysis
PUF Adsorbent

PROJECT: Livingston / BN

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ENVIROCON, Inc.
Livingston, MT

LAB NO.	90-32935	90-32936
SAMPLE IDENTIFICATION	140101-Air-003	140101-Air-004
SAMPLE SUBMITTED	11/30/90	11/30/90
DATE REPORTED	01/11/91	01/11/91
SAMPLE DATE	11/25/90	11/28/90

Parameter	ug/filter medium	ug/filter medium
Acenaphthene	0.7	<0.5
Acenaphthylene	<0.5	<0.5
Anthracene	<0.5	<0.5
Benzo(a)anthracene	<0.5	<0.5
Benzo(a)pyrene	<0.5	<0.5
Benzo(b)fluoranthene	<0.5	<0.5
Benzo(ghi)perylene	<0.5	<0.5
Benzo(k)fluoranthene	<0.5	<0.5
Chrysene	<0.5	<0.5
Dibenzo(a,h)anthracene	<0.5	<0.5
Fluoranthene	<0.5	<0.5
Fluorene	1.0	<0.5
Ideno(1,2,3-cd)pyrene	<0.5	<0.5
Naphthalene	1.7	<0.5
Phenanthrene	3.6	<0.5
Pyrene	<0.5	<0.5

Remarks: Analysis by GC/MS
procedures outlined in EPA
Method T013.Q.A. Review: *A. Stender*



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LIVINGSTON MT - 59047

SEMIVOLATILE SURROGATE RECOVERY

PROJECT: Livingston/BN

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ENVIROCON, Inc.
Livingston, Mt.

PUF

SAMPLE NO.	S1 (NBZ) #	S2 (FBP) #	S3 (TPH) #
	% Recovery	% Recovery	% Recovery
90-32933 Filter	97	91	111
90-32933 Puff	73	77	64
90-32934 Filter	81	87	89
90-32934 Puff	73	71	79
90-32935 Filter	80	94	90
90-32935 Puff	68	73	70
90-32936 Filter	82	82	75
90-32936 Puff	82	90	73

S1 (NBZ) = Nitrobenzene-d5
S2 (FBP) = 2-Fluorobiphenyl
S3 (TPH) = Terphenyl-d14QC LIMITS (% Recovery)
(35-114)
(43-116)
(33-141)NOTE: 1 ml of a 50 ng/ul surrogate standard mix was added
to the Soxhlet solvent.

Column to be used to flag recovery values with an asterisk

* Values outside of contract required QC limits

Q.A. Review: for Studies



ENERGY LABORATORIES, INC.

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FAX (406) 252-6069 • 1-800-873-5227ENVIROCON
PO BOX 1154
LIVINGSTON MT 59047Air Analysis
Glass Fiber Filter PUF

PROJECT: Livingston / BN

LAB NO.	90-34879	90-34880
SAMPLE IDENTIFICATION	140101-Air-005	140101-Air-006
SAMPLE SUBMITTED	12/26/90	12/26/90
DATE REPORTED	01/18/91	01/18/91
SAMPLE DATE	12/04/90	12/11/90
SAMPLE TIME	1715	1700

PARAMETER	ug/filter medium	ug/filter medium
Acenaphthene	<0.5	<0.5
Acenaphthylene	<0.5	<0.5
Anthracene	<0.5	<0.5
Benzo(a)anthracene	<0.5	<0.5
Benzo(a)pyrene	<0.5	<0.5
Benzo(b)fluoranthene	0.5	<0.5
Benzo(ghi)perylene	<0.5	<0.5
Benzo(k)fluoranthene	<0.5	<0.5
Chrysene	<0.5	<0.5
Dibenzo(a,h)anthracene	<0.5	<0.5
Fluoranthene	<0.5	<0.5
Fluorene	<0.5	<0.5
Ideno(1,2,3-cd)pyrene	<0.5	<0.5
Naphthalene	<0.5	<0.5
Phenanthrene	<0.5	<0.5
Pyrene	<0.5	<0.5

REMARKS: Analysis by GC/MS
procedures outlined in
EPA Method T013.

Q.A. Review: _____

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Livingston, Mt.



ENERGY LABORATORIES, INC.

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ENVIROCON, Inc.
Livingston, MTENVIROCON
PO BOX 1154
LIVINGSTON MT 59047Air Analysis
PUF Adsorbent

PROJECT: Livingston / BN

LAB NO.	90-34879	90-34880
SAMPLE IDENTIFICATION	140101-Air-005	140101-Air-006
SAMPLE SUBMITTED	12/26/90	12/26/90
DATE REPORTED	01/18/91	01/18/91
SAMPLE DATE	12/04/90	12/11/90
SAMPLE TIME	1715	1700

PARAMETER	ug/filter medium	ug/filter medium
Acenaphthene	0.6	<0.5
Acenaphthylene	0.6	<0.5
Anthracene	0.6	<0.5
Benzo(a)anthracene	<0.5	<0.5
Benzo(a)pyrene	<0.5	<0.5
Benzo(b)fluoranthene	<0.5	<0.5
Benzo(ghi)perylene	<0.5	<0.5
Benzo(k)fluoranthene	<0.5	<0.5
Chrysene	<0.5	<0.5
Dibenzo(a,h)anthracene	<0.5	<0.5
Fluoranthene	1.3	0.6
Fluorene	2.4	1.5
Ideno(1,2,3-cd)pyrene	<0.5	<0.5
Naphthalene	1.3	1.0
Phenanthrene	5.6	3.3
Pyrene	0.9	<0.5

REMARKS: Analysis by GC/MS
procedures outlined in
EPA Method T013.

Q.A. Review: _____



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PO BOX 1154
LIVINGSTON MT 59047Air Analysis
Glass Fiber Filter (PUF)

PROJECT: Livingston / BN

LAB NO.	90-34881
SAMPLE IDENTIFICATION	140101-Air-007
SAMPLE SUBMITTED	12/26/90
DATE REPORTED	01/18/91
SAMPLE DATE	12/18/90
SAMPLE TIME	1100

PARAMETER	ug/filter medium
Acenaphthene	<0.5
Acenaphthylene	<0.5
Anthracene	<0.5
Benzo(a)anthracene	<0.5
Benzo(a)pyrene	<0.5
Benzo(b)fluoranthene	0.8
Benzo(ghi)perylene	<0.5
Benzo(k)fluoranthene	<0.5
Chrysene	0.5
Dibenzo(a,h)anthracene	<0.5
Fluoranthene	0.6
Fluorene	<0.5
Ideno(1,2,3-cd)pyrene	<0.5
Naphthalene	<0.5
Phenanthrene	<0.5
Pyrene	0.5

REMARKS: Analysis by GC/MS
procedures outlined in
EPA Method T013.

Q.A. Review: _____

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JAN 21 1991

ENVIROCON, Inc.
Livingston, Mt.Met
Station PUF

Metals - Laboratory Data

(Appendix C)



Client: Bison
Report Date: 1/28/91

Project Number: 322/001
Date Received: 1/11/91

NEA ID: 91-Q201

Client ID: 09565

Site:

Sample Date:

Exposed Area: 406.0 cm²

Deposit Mass: 39600. \pm 500. ug

Volume of Air Sampled: 1486. \pm 148.6 m³

Suspended Particulates (P): 26.65 \pm 2.686 ug/m³

Element	ug/filter	percent	ug/m ³
Al	0.0000 \pm 1091.	0.0000 \pm 2.754	0.0000 \pm 0.7339
P	0.0000 \pm 20.79	0.0000 \pm 0.0525	0.0000 \pm 0.0140
S	410.9 \pm 76.21	1.038 \pm 0.1929	0.2765 \pm 0.0583
Cl	0.0000 \pm 30.86	0.0000 \pm 0.0779	0.0000 \pm 0.0208
K	664.2 \pm 77.67	1.677 \pm 0.1973	0.4470 \pm 0.0688
Ca	2237. \pm 251.8	5.649 \pm 0.6398	1.505 \pm 0.2267
Ti	90.62 \pm 8.039	0.2288 \pm 0.0205	0.0610 \pm 0.0082
V	2.680 \pm 6.009	0.0068 \pm 0.0152	0.0018 \pm 0.0040
Cr	0.0000 \pm 4.263	0.0000 \pm 0.0108	0.0000 \pm 0.0029
Mn	13.56 \pm 3.654	0.0342 \pm 0.0092	0.0091 \pm 0.0026
Fe	749.9 \pm 49.94	1.894 \pm 0.1284	0.5046 \pm 0.0606
Ni	0.0000 \pm 3.613	0.0000 \pm 0.0091	0.0000 \pm 0.0024
Cu	7.633 \pm 2.517	0.0193 \pm 0.0064	0.0051 \pm 0.0018
Zn	0.0000 \pm 34.88	0.0000 \pm 0.0881	0.0000 \pm 0.0235
Ga	0.0000 \pm 2.314	0.0000 \pm 0.0058	0.0000 \pm 0.0016
Ge	0.0000 \pm 1.989	0.0000 \pm 0.0050	0.0000 \pm 0.0013
As	2.274 \pm 6.740	0.0057 \pm 0.0170	0.0015 \pm 0.0045
Se	2.111 \pm 2.314	0.0053 \pm 0.0058	0.0014 \pm 0.0016
Br	8.607 \pm 2.761	0.0217 \pm 0.0070	0.0058 \pm 0.0019
Rb	0.0000 \pm 3.695	0.0000 \pm 0.0093	0.0000 \pm 0.0025
Sr	16.85 \pm 4.222	0.0425 \pm 0.0107	0.0113 \pm 0.0031
Y	0.0000 \pm 4.344	0.0000 \pm 0.0110	0.0000 \pm 0.0029
Zr	38.04 \pm 9.500	0.0961 \pm 0.0240	0.0256 \pm 0.0069
Mo	161.5 \pm 16.81	0.4079 \pm 0.0428	0.1087 \pm 0.0157
Pd	47.91 \pm 18.39	0.1210 \pm 0.0465	0.0322 \pm 0.0128
Ag	45.88 \pm 23.91	0.1159 \pm 0.0604	0.0309 \pm 0.0164
Cd	18.68 \pm 36.58	0.0472 \pm 0.0924	0.0126 \pm 0.0246
In	77.34 \pm 38.85	0.1953 \pm 0.0981	0.0520 \pm 0.0267
Sn	107.5 \pm 46.49	0.2714 \pm 0.1174	0.0723 \pm 0.0321
Sb	29.92 \pm 54.61	0.0756 \pm 0.1379	0.0201 \pm 0.0368
Ba	0.0000 \pm 243.7	0.0000 \pm 0.6154	0.0000 \pm 0.1640
La	170.5 \pm 235.6	0.4306 \pm 0.5951	0.1148 \pm 0.1590
Hg	0.0000 \pm 5.237	0.0000 \pm 0.0132	0.0000 \pm 0.0035
Pb	15.39 \pm 12.18	0.0389 \pm 0.0308	0.0104 \pm 0.0083

Client: Bison
Report Date: 1/28/91

Project Number: 322/001
Date Received: 1/11/91

NEA ID: 91-Q202

Client ID: 09567

Site:

Sample Date:

Exposed Area: 406.0 cm²

Deposit Mass: 14100. +- 500. ug

Volume of Air Sampled: 1555. +- 155.5 m³

Suspended Particulates (P): 9.068 +- 0.9621 ug/m³

Element	ug/filter	percent	ug/m ³
Al	0.0000 +1049.	0.0000 +- 7.440	0.0000 +- 0.6747
P	0.0000 +- 20.26	0.0000 +- 0.1437	0.0000 +- 0.0130
S	98.33 +- 53.92	0.6974 +- 0.3832	0.0632 +- 0.0352
Cl	0.0000 +- 28.30	0.0000 +- 0.2007	0.0000 +- 0.0182
K	512.8 +- 60.90	3.637 +- 0.4508	0.3298 +- 0.0512
Ca	2015. +-226.9	14.29 +- 1.687	1.296 +- 0.1951
Ti	51.20 +- 6.496	0.3631 +- 0.0478	0.0329 +- 0.0053
V	2.517 +- 5.643	0.0179 +- 0.0400	0.0016 +- 0.0036
Cr	0.0000 +- 4.182	0.0000 +- 0.0297	0.0000 +- 0.0027
Mn	1.989 +- 3.451	0.0141 +- 0.0245	0.0013 +- 0.0022
Fe	207.4 +- 23.79	1.471 +- 0.1766	0.1334 +- 0.0203
Ni	0.0000 +- 3.451	0.0000 +- 0.0245	0.0000 +- 0.0022
Cu	0.8932 +- 2.233	0.0063 +- 0.0158	0.0006 +- 0.0014
Zn	0.0000 +- 31.51	0.0000 +- 0.2234	0.0000 +- 0.0203
Ga	0.0000 +- 2.111	0.0000 +- 0.0150	0.0000 +- 0.0014
Ge	0.0000 +- 1.868	0.0000 +- 0.0132	0.0000 +- 0.0012
As	0.0000 +- 6.496	0.0000 +- 0.0461	0.0000 +- 0.0042
Se	0.0000 +- 2.314	0.0000 +- 0.0164	0.0000 +- 0.0015
Br	0.0000 +- 2.639	0.0000 +- 0.0187	0.0000 +- 0.0017
Rb	0.3248 +- 3.613	0.0023 +- 0.0256	0.0002 +- 0.0023
Sr	22.86 +- 4.182	0.1621 +- 0.0302	0.0147 +- 0.0031
Y	9.257 +- 4.304	0.0657 +- 0.0306	0.0060 +- 0.0028
Zr	19.61 +- 9.582	0.1391 +- 0.0681	0.0126 +- 0.0063
Mo	179.2 +- 17.26	1.271 +- 0.1304	0.1152 +- 0.0160
Pd	57.25 +- 17.42	0.4060 +- 0.1244	0.0368 +- 0.0118
Ag	0.0000 +- 22.65	0.0000 +- 0.1607	0.0000 +- 0.0146
Cd	0.0000 +- 36.05	0.0000 +- 0.2557	0.0000 +- 0.0232
In	0.0000 +- 38.65	0.0000 +- 0.2741	0.0000 +- 0.0249
Sn	0.0000 +- 46.16	0.0000 +- 0.3274	0.0000 +- 0.0297
Sb	0.0000 +- 54.61	0.0000 +- 0.3873	0.0000 +- 0.0351
Ba	0.0000 +-242.1	0.0000 +- 1.717	0.0000 +- 0.1557
La	0.0000 +-235.5	0.0000 +- 1.670	0.0000 +- 0.1514
Hg	0.0000 +- 5.156	0.0000 +- 0.0366	0.0000 +- 0.0033
Pb	12.42 +- 11.86	0.0881 +- 0.0841	0.0080 +- 0.0077

Client: Bison
Report Date: 1/28/91

Project Number: 322/001
Date Received: 1/11/91

NEA ID: 91-Q203

Client ID: 09571

Site:

Sample Date:

Exposed Area: 406.0 cm²

Deposit Mass: 15600. +- 500. ug

Volume of Air Sampled: 1577. +- 157.7 m³

Suspended Particulates (P): 9.892 +- 1.039 ug/m³

Element	ug/filter	percent	ug/m ³
Al	0.0000 +1047.	0.0000 +- 6.715	0.0000 +- 0.6642
P	0.0000 +- 20.26	0.0000 +- 0.1299	0.0000 +- 0.0128
S	0.0000 +- 52.86	0.0000 +- 0.3389	0.0000 +- 0.0335
Cl	0.0000 +- 29.43	0.0000 +- 0.1887	0.0000 +- 0.0187
K	523.3 +- 62.20	3.355 +- 0.4130	0.3319 +- 0.0515
Ca	2004. +-225.8	12.85 +- 1.505	1.271 +- 0.1914
Ti	59.15 +- 6.658	0.3792 +- 0.0444	0.0375 +- 0.0056
V	1.340 +- 5.765	0.0086 +- 0.0370	0.0008 +- 0.0037
Cr	0.0000 +- 4.182	0.0000 +- 0.0268	0.0000 +- 0.0027
Mn	10.11 +- 3.410	0.0648 +- 0.0220	0.0064 +- 0.0023
Fe	556.6 +- 40.48	3.568 +- 0.2836	0.3530 +- 0.0436
Ni	0.0000 +- 3.532	0.0000 +- 0.0226	0.0000 +- 0.0022
Cu	8.607 +- 2.355	0.0552 +- 0.0152	0.0055 +- 0.0016
Zn	0.0000 +- 31.83	0.0000 +- 0.2040	0.0000 +- 0.0202
Ga	0.0000 +- 2.111	0.0000 +- 0.0135	0.0000 +- 0.0013
Ge	2.680 +- 1.868	0.0172 +- 0.0120	0.0017 +- 0.0012
As	3.938 +- 6.577	0.0252 +- 0.0422	0.0025 +- 0.0042
Se	1.340 +- 2.314	0.0086 +- 0.0148	0.0008 +- 0.0015
Br	0.0000 +- 2.720	0.0000 +- 0.0174	0.0000 +- 0.0017
Rb	7.511 +- 3.613	0.0481 +- 0.0232	0.0048 +- 0.0023
Sr	20.87 +- 4.182	0.1338 +- 0.0271	0.0132 +- 0.0030
Y	4.750 +- 4.344	0.0304 +- 0.0279	0.0030 +- 0.0028
Zr	15.35 +- 9.541	0.0984 +- 0.0612	0.0097 +- 0.0061
Mo	167.8 +- 16.93	1.076 +- 0.1139	0.1064 +- 0.0151
Pd	16.65 +- 17.70	0.1067 +- 0.1135	0.0106 +- 0.0113
Ag	0.0000 +- 23.79	0.0000 +- 0.1525	0.0000 +- 0.0151
Cd	0.0000 +- 36.58	0.0000 +- 0.2345	0.0000 +- 0.0232
In	0.0000 +- 37.96	0.0000 +- 0.2433	0.0000 +- 0.0241
Sn	0.0000 +- 46.16	0.0000 +- 0.2959	0.0000 +- 0.0293
Sb	0.0000 +- 54.61	0.0000 +- 0.3500	0.0000 +- 0.0346
Ba	0.0000 +-245.5	0.0000 +- 1.574	0.0000 +- 0.1557
La	0.0000 +-238.2	0.0000 +- 1.527	0.0000 +- 0.1510
Hg	0.0000 +- 5.156	0.0000 +- 0.0331	0.0000 +- 0.0033
Pb	0.0000 +- 12.02	0.0000 +- 0.0770	0.0000 +- 0.0076

Client: Bison
Report Date: 1/28/91

Project Number: 322/001
Date Received: 1/11/91

NEA ID: 91-Q204

Client ID: 09574

Site:

Sample Date:

Exposed Area: 406.0 cm²

Deposit Mass: 26600. +- 500. ug

Volume of Air Sampled: 1552. +- 155.2 m³

Suspended Particulates (P): 17.14 +- 1.744 ug/m³

Element	ug/filter	percent	ug/m ³
Al	0.0000 +1073.	0.0000 +- 4.034	0.0000 +- 0.6914
P	0.0000 +- 20.42	0.0000 +- 0.0768	0.0000 +- 0.0132
S	221.6 +- 63.66	0.8332 +- 0.2398	0.1428 +- 0.0434
Cl	0.0000 +- 30.69	0.0000 +- 0.1154	0.0000 +- 0.0198
K	552.6 +- 65.49	2.077 +- 0.2493	0.3560 +- 0.0552
Ca	2138. +-240.8	8.039 +- 0.9176	1.378 +- 0.2075
Ti	86.19 +- 7.755	0.3240 +- 0.0298	0.0555 +- 0.0075
V	0.0000 +- 5.928	0.0000 +- 0.0223	0.0000 +- 0.0038
Cr	0.1218 +- 4.222	0.0005 +- 0.0159	0.0001 +- 0.0027
Mn	9.541 +- 3.613	0.0359 +- 0.0136	0.0061 +- 0.0024
Fe	715.4 +- 48.23	2.689 +- 0.1882	0.4609 +- 0.0556
Ni	0.0000 +- 3.613	0.0000 +- 0.0136	0.0000 +- 0.0023
Cu	5.765 +- 2.314	0.0217 +- 0.0087	0.0037 +- 0.0015
Zn	0.0000 +- 31.38	0.0000 +- 0.1180	0.0000 +- 0.0202
Ga	0.0000 +- 2.111	0.0000 +- 0.0079	0.0000 +- 0.0014
Ge	0.0000 +- 1.786	0.0000 +- 0.0067	0.0000 +- 0.0012
As	4.344 +- 6.577	0.0163 +- 0.0247	0.0028 +- 0.0042
Se	0.0000 +- 2.355	0.0000 +- 0.0089	0.0000 +- 0.0015
Br	2.111 +- 2.680	0.0079 +- 0.0101	0.0014 +- 0.0017
Rb	4.953 +- 3.613	0.0186 +- 0.0136	0.0032 +- 0.0024
Sr	27.36 +- 4.141	0.1029 +- 0.0157	0.0176 +- 0.0032
Y	5.765 +- 4.263	0.0217 +- 0.0160	0.0037 +- 0.0028
Zr	20.99 +- 9.785	0.0789 +- 0.0368	0.0135 +- 0.0064
Mo	148.6 +- 16.32	0.5586 +- 0.0622	0.0957 +- 0.0142
Pd	0.0000 +- 17.17	0.0000 +- 0.0646	0.0000 +- 0.0111
Ag	31.14 +- 22.70	0.1171 +- 0.0853	0.0201 +- 0.0148
Cd	58.14 +- 35.93	0.2186 +- 0.1351	0.0375 +- 0.0235
In	63.74 +- 37.35	0.2396 +- 0.1405	0.0411 +- 0.0244
Sn	16.73 +- 46.16	0.0629 +- 0.1735	0.0108 +- 0.0298
Sb	73.97 +- 54.73	0.2781 +- 0.2058	0.0477 +- 0.0356
Ba	74.34 +-242.6	0.2795 +- 0.9120	0.0479 +- 0.1564
La	703.6 +-232.8	2.645 +- 0.8764	0.4533 +- 0.1567
Hg	0.0000 +- 5.034	0.0000 +- 0.0189	0.0000 +- 0.0032
Pb	0.0000 +- 11.94	0.0000 +- 0.0449	0.0000 +- 0.0077

Client: Bison
Report Date: 1/28/91

Project Number: 322/001
Date Received: 1/11/91

NEA ID: 91-Q205

Client ID: 09575

Site:

Sample Date:

Exposed Area: 406.0 cm²

Deposit Mass: 25400. +- 500. ug

Volume of Air Sampled: 1584. +- 158.4 m³

Suspended Particulates (P): 16.04 +- 1.634 ug/m³

Element	ug/filter	percent	ug/m ³
Al	0.0000 +1067.	0.0000 +- 4.202	0.0000 +- 0.6738
P	0.0000 +- 20.50	0.0000 +- 0.0807	0.0000 +- 0.0129
S	142.9 +- 55.46	0.5625 +- 0.2186	0.0902 +- 0.0362
Cl	0.0000 +- 29.56	0.0000 +- 0.1164	0.0000 +- 0.0187
K	581.8 +- 68.57	2.291 +- 0.2737	0.3673 +- 0.0568
Ca	2241. +-252.3	8.823 +- 1.008	1.415 +- 0.2130
Ti	87.53 +- 7.755	0.3446 +- 0.0313	0.0553 +- 0.0074
V	0.0000 +- 6.049	0.0000 +- 0.0238	0.0000 +- 0.0038
Cr	2.233 +- 4.466	0.0088 +- 0.0176	0.0014 +- 0.0028
Mn	8.445 +- 3.695	0.0332 +- 0.0146	0.0053 +- 0.0024
Fe	751.9 +- 50.02	2.960 +- 0.2054	0.4747 +- 0.0570
Ni	0.0000 +- 3.532	0.0000 +- 0.0139	0.0000 +- 0.0022
Cu	4.628 +- 2.314	0.0182 +- 0.0091	0.0029 +- 0.0015
Zn	0.0000 +- 31.30	0.0000 +- 0.1232	0.0000 +- 0.0198
Ga	0.0000 +- 2.030	0.0000 +- 0.0080	0.0000 +- 0.0013
Ge	3.207 +- 1.868	0.0126 +- 0.0074	0.0020 +- 0.0012
As	0.0000 +- 6.496	0.0000 +- 0.0256	0.0000 +- 0.0041
Se	1.827 +- 2.314	0.0072 +- 0.0091	0.0012 +- 0.0015
Br	5.522 +- 2.680	0.0217 +- 0.0106	0.0035 +- 0.0017
Rb	12.26 +- 3.613	0.0483 +- 0.0143	0.0077 +- 0.0024
Sr	24.32 +- 4.182	0.0957 +- 0.0166	0.0154 +- 0.0031
Y	0.0000 +- 4.344	0.0000 +- 0.0171	0.0000 +- 0.0027
Zr	33.41 +- 9.866	0.1316 +- 0.0389	0.0211 +- 0.0066
Mo	173.9 +- 17.26	0.6848 +- 0.0693	0.1098 +- 0.0155
Pd	19.77 +- 18.23	0.0778 +- 0.0718	0.0125 +- 0.0116
Ag	10.76 +- 23.79	0.0424 +- 0.0937	0.0068 +- 0.0150
Cd	0.0000 +- 36.05	0.0000 +- 0.1419	0.0000 +- 0.0228
In	0.0000 +- 37.96	0.0000 +- 0.1495	0.0000 +- 0.0240
Sn	0.0000 +- 46.16	0.0000 +- 0.1817	0.0000 +- 0.0291
Sb	0.0000 +- 56.35	0.0000 +- 0.2219	0.0000 +- 0.0356
Ba	0.0000 +-243.4	0.0000 +- 0.9584	0.0000 +- 0.1537
La	503.4 +-234.1	1.982 +- 0.9226	0.3178 +- 0.1512
Hg	0.0000 +- 5.237	0.0000 +- 0.0206	0.0000 +- 0.0033
Pb	11.90 +- 11.86	0.0468 +- 0.0467	0.0075 +- 0.0075

Client: Bison
Report Date: 1/28/91

Project Number: 322/001
Date Received: 1/11/91

NEA ID: 91-Q206

Client ID: 09568

Site:

Sample Date:

Exposed Area: 406.0 cm²

Deposit Mass: 26800. +- 500. ug

Volume of Air Sampled: 1547.

+- 154.7 m³

Suspended Particulates (P): 17.32 +- 1.762 ug/m³

Element	ug/filter	percent	ug/m ³
Al	0.0000 +1061.	0.0000 +- 3.960	0.0000 +- 0.6860
P	0.0000 +- 20.34	0.0000 +- 0.0759	0.0000 +- 0.0131
S	0.0000 +- 64.19	0.0000 +- 0.2395	0.0000 +- 0.0415
Cl	1264. +-150.0	4.717 +- 0.5665	0.8172 +- 0.1268
K	1032. +-118.4	3.849 +- 0.4476	0.6669 +- 0.1015
Ca	1957. +-220.6	7.302 +- 0.8343	1.265 +- 0.1906
Ti	77.34 +- 7.105	0.2886 +- 0.0271	0.0500 +- 0.0068
V	7.186 +- 5.765	0.0268 +- 0.0215	0.0046 +- 0.0038
Cr	0.0000 +- 4.182	0.0000 +- 0.0156	0.0000 +- 0.0027
Mn	1.868 +- 3.289	0.0070 +- 0.0123	0.0012 +- 0.0021
Fe	114.9 +- 19.61	0.4286 +- 0.0736	0.0742 +- 0.0147
Ni	0.0000 +- 3.532	0.0000 +- 0.0132	0.0000 +- 0.0023
Cu	0.0000 +- 3.004	0.0000 +- 0.0112	0.0000 +- 0.0019
Zn	825.0 +- 85.67	3.078 +- 0.3248	0.5333 +- 0.0769
Ga	0.0000 +- 3.613	0.0000 +- 0.0135	0.0000 +- 0.0023
Ge	0.0000 +- 2.395	0.0000 +- 0.0089	0.0000 +- 0.0015
As	18.92 +- 22.65	0.0706 +- 0.0845	0.0122 +- 0.0147
Se	0.0000 +- 2.477	0.0000 +- 0.0092	0.0000 +- 0.0016
Br	45.92 +- 4.060	0.1713 +- 0.0155	0.0297 +- 0.0040
Rb	2.436 +- 3.857	0.0091 +- 0.0144	0.0016 +- 0.0025
Sr	15.10 +- 4.101	0.0564 +- 0.0153	0.0098 +- 0.0028
Y	0.0000 +- 4.507	0.0000 +- 0.0168	0.0000 +- 0.0029
Zr	35.93 +- 9.500	0.1341 +- 0.0355	0.0232 +- 0.0066
Mo	163.5 +- 16.48	0.6101 +- 0.0626	0.1057 +- 0.0150
Pd	13.03 +- 18.76	0.0486 +- 0.0700	0.0084 +- 0.0122
Ag	0.0000 +- 24.93	0.0000 +- 0.0930	0.0000 +- 0.0161
Cd	63.09 +- 37.96	0.2354 +- 0.1417	0.0408 +- 0.0249
In	25.05 +- 39.42	0.0935 +- 0.1471	0.0162 +- 0.0255
Sn	60.49 +- 49.45	0.2257 +- 0.1846	0.0391 +- 0.0322
Sb	0.0000 +- 57.25	0.0000 +- 0.2136	0.0000 +- 0.0370
Ba	0.0000 +-246.2	0.0000 +- 0.9188	0.0000 +- 0.1592
La	56.84 +-238.2	0.2121 +- 0.8888	0.0367 +- 0.1540
Hg	0.0000 +- 6.252	0.0000 +- 0.0233	0.0000 +- 0.0040
Pb	408.4 +- 25.42	1.524 +- 0.0990	0.2640 +- 0.0311

Client: Bison
Report Date: 1/28/91

Project Number: 322/001
Date Received: 1/11/91

NEA ID: 91-Q207

Client ID: 09570

Site:

Sample Date:

Exposed Area: 406.0 cm²

Deposit Mass: 17700. +- 500. ug

Volume of Air Sampled: 1570. +- 157.0 m³

Suspended Particulates (P): 11.27 +- 1.172 ug/m³

Element	ug/filter	percent	ug/m ³
Al	0.0000 +1056.	0.0000 +- 5.964	0.0000 +- 0.6724
P	0.0000 +- 20.38	0.0000 +- 0.1151	0.0000 +- 0.0130
S	0.0000 +- 49.21	0.0000 +- 0.2780	0.0000 +- 0.0313
Cl	0.0000 +- 29.43	0.0000 +- 0.1663	0.0000 +- 0.0187
K	477.9 +- 57.04	2.700 +- 0.3312	0.3044 +- 0.0474
Ca	1759. +-198.3	9.937 +- 1.155	1.120 +- 0.1688
Ti	60.94 +- 6.496	0.3443 +- 0.0380	0.0388 +- 0.0057
V	7.673 +- 5.643	0.0434 +- 0.0319	0.0049 +- 0.0036
Cr	0.0000 +- 4.182	0.0000 +- 0.0236	0.0000 +- 0.0027
Mn	3.898 +- 3.207	0.0220 +- 0.0181	0.0025 +- 0.0021
Fe	239.9 +- 25.33	1.355 +- 0.1482	0.1528 +- 0.0222
Ni	0.0000 +- 3.451	0.0000 +- 0.0195	0.0000 +- 0.0022
Cu	2.680 +- 2.314	0.0151 +- 0.0131	0.0017 +- 0.0015
Zn	0.0000 +- 31.55	0.0000 +- 0.1782	0.0000 +- 0.0201
Ga	0.0000 +- 2.111	0.0000 +- 0.0119	0.0000 +- 0.0013
Ge	2.314 +- 1.868	0.0131 +- 0.0106	0.0015 +- 0.0012
As	0.0000 +- 6.455	0.0000 +- 0.0365	0.0000 +- 0.0041
Se	0.0000 +- 2.355	0.0000 +- 0.0133	0.0000 +- 0.0015
Br	0.3248 +- 2.680	0.0018 +- 0.0151	0.0002 +- 0.0017
Rb	14.29 +- 3.654	0.0807 +- 0.0208	0.0091 +- 0.0025
Sr	24.40 +- 4.222	0.1379 +- 0.0242	0.0155 +- 0.0031
Y	0.0000 +- 4.344	0.0000 +- 0.0245	0.0000 +- 0.0028
Zr	14.94 +- 8.770	0.0844 +- 0.0496	0.0095 +- 0.0057
Mo	152.9 +- 15.71	0.8638 +- 0.0921	0.0974 +- 0.0140
Pd	0.0000 +- 18.23	0.0000 +- 0.1030	0.0000 +- 0.0116
Ag	15.31 +- 23.79	0.0865 +- 0.1344	0.0097 +- 0.0152
Cd	68.45 +- 35.73	0.3867 +- 0.2021	0.0436 +- 0.0232
In	0.0000 +- 37.23	0.0000 +- 0.2103	0.0000 +- 0.0237
Sn	0.0000 +- 46.16	0.0000 +- 0.2608	0.0000 +- 0.0294
Sb	35.24 +- 54.61	0.1991 +- 0.3086	0.0224 +- 0.0349
Ba	141.9 +-243.1	0.8017 +- 1.373	0.0904 +- 0.1551
La	749.9 +-235.8	4.237 +- 1.337	0.4776 +- 0.1576
Hg	0.0000 +- 5.237	0.0000 +- 0.0296	0.0000 +- 0.0033
Pb	6.577 +- 11.86	0.0372 +- 0.0670	0.0042 +- 0.0076

Client: Bison
Report Date: 1/28/91

Project Number: 322/001
Date Received: 1/11/91

NEA ID: 91-Q208

Client ID: 09572

Site:

Sample Date:

Exposed Area: 406.0 cm²

Deposit Mass: 17500. +- 500. ug

Volume of Air Sampled: 1544.

+- 154.4 m³

Suspended Particulates (P):

11.33 +- 1.179 ug/m³

Element	ug/filter	percent	ug/m ³
Al	0.0000 +1059.	0.0000 +- 6.053	0.0000 +- 0.6860
P	0.0000 +- 20.38	0.0000 +- 0.1165	0.0000 +- 0.0132
S	25.50 +- 52.90	0.1457 +- 0.3023	0.0165 +- 0.0343
Cl	0.0000 +- 30.57	0.0000 +- 0.1747	0.0000 +- 0.0198
K	438.1 +- 52.70	2.503 +- 0.3095	0.2837 +- 0.0444
Ca	1497. +-169.0	8.552 +- 0.9962	0.9692 +- 0.1462
Ti	56.96 +- 5.846	0.3255 +- 0.0347	0.0369 +- 0.0053
V	0.0000 +- 5.359	0.0000 +- 0.0306	0.0000 +- 0.0035
Cr	0.0000 +- 3.816	0.0000 +- 0.0218	0.0000 +- 0.0025
Mn	6.902 +- 3.045	0.0394 +- 0.0174	0.0045 +- 0.0020
Fe	146.6 +- 21.03	0.8378 +- 0.1225	0.0950 +- 0.0166
Ni	0.0000 +- 3.613	0.0000 +- 0.0206	0.0000 +- 0.0023
Cu	2.761 +- 2.477	0.0158 +- 0.0142	0.0018 +- 0.0016
Zn	0.0000 +- 36.22	0.0000 +- 0.2069	0.0000 +- 0.0235
Ga	0.0000 +- 2.436	0.0000 +- 0.0139	0.0000 +- 0.0016
Ge	0.8120 +- 1.989	0.0046 +- 0.0114	0.0005 +- 0.0013
As	2.883 +- 7.470	0.0165 +- 0.0427	0.0019 +- 0.0048
Se	0.0000 +- 2.355	0.0000 +- 0.0135	0.0000 +- 0.0015
Br	4.588 +- 2.801	0.0262 +- 0.0160	0.0030 +- 0.0018
Rb	0.0000 +- 3.695	0.0000 +- 0.0211	0.0000 +- 0.0024
Sr	20.99 +- 4.141	0.1199 +- 0.0239	0.0136 +- 0.0030
Y	6.212 +- 4.344	0.0355 +- 0.0248	0.0040 +- 0.0028
Zr	23.10 +- 8.607	0.1320 +- 0.0493	0.0150 +- 0.0058
Mo	154.1 +- 15.43	0.8804 +- 0.0917	0.0998 +- 0.0141
Pd	10.39 +- 17.70	0.0594 +- 0.1012	0.0067 +- 0.0115
Ag	0.0000 +- 23.22	0.0000 +- 0.1327	0.0000 +- 0.0150
Cd	4.344 +- 36.05	0.0248 +- 0.2060	0.0028 +- 0.0234
In	93.10 +- 38.25	0.5320 +- 0.2191	0.0603 +- 0.0255
Sn	72.43 +- 46.32	0.4139 +- 0.2650	0.0469 +- 0.0304
Sb	0.0000 +- 55.46	0.0000 +- 0.3169	0.0000 +- 0.0359
Ba	0.0000 +-244.5	0.0000 +- 1.397	0.0000 +- 0.1584
La	0.0000 +-235.5	0.0000 +- 1.346	0.0000 +- 0.1525
Hg	0.0000 +- 5.400	0.0000 +- 0.0309	0.0000 +- 0.0035
Pb	49.65 +- 12.79	0.2837 +- 0.0735	0.0322 +- 0.0089

Client: Bison
Report Date: 1/28/91

Project Number: 322/001
Date Received: 1/11/91

NEA ID: 91-Q209

Client ID: 09577

Site:

Sample Date:

Exposed Area: 406.0 cm²

Deposit Mass: 24800. +- 500. ug

Volume of Air Sampled: 1576.

+- 157.6 m³

Suspended Particulates (P):

15.74 +- 1.605 ug/m³

Element	ug/filter	percent	ug/m ³
Al	0.0000 +1067.	0.0000 +- 4.301	0.0000 +- 0.6768
P	0.0000 +- 20.54	0.0000 +- 0.0828	0.0000 +- 0.0130
S	7.308 +- 56.80	0.0295 +- 0.2290	0.0046 +- 0.0360
Cl	356.9 +- 54.00	1.439 +- 0.2197	0.2265 +- 0.0411
K	871.3 +-100.6	3.513 +- 0.4116	0.5528 +- 0.0844
Ca	2188. +-246.4	8.824 +- 1.009	1.389 +- 0.2091
Ti	92.61 +- 7.917	0.3734 +- 0.0328	0.0588 +- 0.0077
V	0.0000 +- 5.806	0.0000 +- 0.0234	0.0000 +- 0.0037
Cr	0.0000 +- 4.222	0.0000 +- 0.0170	0.0000 +- 0.0027
Mn	9.094 +- 3.695	0.0367 +- 0.0149	0.0058 +- 0.0024
Fe	544.4 +- 39.91	2.195 +- 0.1669	0.3455 +- 0.0428
Ni	0.0000 +- 3.613	0.0000 +- 0.0146	0.0000 +- 0.0023
Cu	20.95 +- 2.923	0.0845 +- 0.0119	0.0133 +- 0.0023
Zn	0.0000 +- 38.12	0.0000 +- 0.1537	0.0000 +- 0.0242
Ga	0.0000 +- 2.558	0.0000 +- 0.0103	0.0000 +- 0.0016
Ge	2.801 +- 1.908	0.0113 +- 0.0077	0.0018 +- 0.0012
As	22.94 +- 12.34	0.0925 +- 0.0498	0.0146 +- 0.0080
Se	0.0000 +- 2.436	0.0000 +- 0.0098	0.0000 +- 0.0015
Br	65.81 +- 4.669	0.2654 +- 0.0196	0.0418 +- 0.0051
Rb	13.07 +- 3.857	0.0527 +- 0.0156	0.0083 +- 0.0026
Sr	29.35 +- 4.344	0.1184 +- 0.0177	0.0186 +- 0.0033
Y	2.233 +- 4.425	0.0090 +- 0.0178	0.0014 +- 0.0028
Zr	29.11 +- 9.419	0.1174 +- 0.0381	0.0185 +- 0.0063
Mo	169.8 +- 16.48	0.6846 +- 0.0679	0.1077 +- 0.0150
Pd	0.0000 +- 18.23	0.0000 +- 0.0735	0.0000 +- 0.0116
Ag	3.979 +- 24.93	0.0160 +- 0.1005	0.0025 +- 0.0158
Cd	24.28 +- 37.11	0.0979 +- 0.1496	0.0154 +- 0.0236
In	0.0000 +- 39.38	0.0000 +- 0.1588	0.0000 +- 0.0250
Sn	22.29 +- 48.56	0.0899 +- 0.1958	0.0141 +- 0.0308
Sb	47.54 +- 55.54	0.1917 +- 0.2240	0.0302 +- 0.0354
Ba	0.0000 +-245.6	0.0000 +- 0.9903	0.0000 +- 0.1558
La	0.0000 +-240.9	0.0000 +- 0.9713	0.0000 +- 0.1528
Hg	0.0000 +- 5.400	0.0000 +- 0.0218	0.0000 +- 0.0034
Pb	187.6 +- 16.24	0.7563 +- 0.0672	0.1190 +- 0.0157

Client: Bison
Report Date: 1/28/91

Project Number: 322/001
Date Received: 1/11/91

NEA ID: 91-Q210

Client ID: 09579

Site:

Sample Date:

Exposed Area: 406.0 cm²

Deposit Mass: 18800. \pm 500. ug

Volume of Air Sampled: 1558. \pm 155.8 m³

Suspended Particulates (P): 12.07 \pm 1.249 ug/m³

Element	ug/filter	percent	ug/m ³
Al	0.0000 \pm 1047.	0.0000 \pm 5.567	0.0000 \pm 0.6718
P	0.0000 \pm 20.14	0.0000 \pm 0.1071	0.0000 \pm 0.0129
S	83.96 \pm 57.37	0.4466 \pm 0.3054	0.0539 \pm 0.0372
Cl	0.0000 \pm 29.48	0.0000 \pm 0.1568	0.0000 \pm 0.0189
K	652.8 \pm 76.33	3.473 \pm 0.4164	0.4190 \pm 0.0645
Ca	2114. \pm 238.1	11.25 \pm 1.301	1.357 \pm 0.2044
Ti	83.07 \pm 7.267	0.4418 \pm 0.0404	0.0533 \pm 0.0071
V	0.0000 \pm 5.684	0.0000 \pm 0.0302	0.0000 \pm 0.0036
Cr	0.0000 \pm 4.182	0.0000 \pm 0.0222	0.0000 \pm 0.0027
Mn	5.765 \pm 3.410	0.0307 \pm 0.0182	0.0037 \pm 0.0022
Fe	359.1 \pm 30.94	1.910 \pm 0.1722	0.2305 \pm 0.0304
Ni	0.0000 \pm 3.451	0.0000 \pm 0.0184	0.0000 \pm 0.0022
Cu	11.16 \pm 2.477	0.0594 \pm 0.0133	0.0072 \pm 0.0017
Zn	0.0000 \pm 31.59	0.0000 \pm 0.1680	0.0000 \pm 0.0203
Ga	0.0000 \pm 2.111	0.0000 \pm 0.0112	0.0000 \pm 0.0014
Ge	1.583 \pm 1.786	0.0084 \pm 0.0095	0.0010 \pm 0.0012
As	8.567 \pm 6.496	0.0456 \pm 0.0346	0.0055 \pm 0.0042
Se	0.0000 \pm 2.233	0.0000 \pm 0.0119	0.0000 \pm 0.0014
Br	1.015 \pm 2.680	0.0054 \pm 0.0143	0.0007 \pm 0.0017
Rb	1.989 \pm 3.573	0.0106 \pm 0.0190	0.0013 \pm 0.0023
Sr	14.86 \pm 4.060	0.0790 \pm 0.0217	0.0095 \pm 0.0028
Y	0.0000 \pm 4.304	0.0000 \pm 0.0229	0.0000 \pm 0.0028
Zr	15.55 \pm 9.541	0.0827 \pm 0.0508	0.0100 \pm 0.0062
Mo	178.2 \pm 17.05	0.9481 \pm 0.0941	0.1144 \pm 0.0158
Pd	3.654 \pm 17.17	0.0194 \pm 0.0914	0.0023 \pm 0.0110
Ag	0.0000 \pm 23.79	0.0000 \pm 0.1266	0.0000 \pm 0.0153
Cd	0.0000 \pm 36.05	0.0000 \pm 0.1918	0.0000 \pm 0.0231
In	0.0000 \pm 37.23	0.0000 \pm 0.1980	0.0000 \pm 0.0239
Sn	48.56 \pm 45.43	0.2583 \pm 0.2418	0.0312 \pm 0.0293
Sb	81.89 \pm 52.98	0.4356 \pm 0.2821	0.0526 \pm 0.0344
Ba	0.0000 \pm 242.0	0.0000 \pm 1.287	0.0000 \pm 0.1553
La	0.0000 \pm 232.8	0.0000 \pm 1.238	0.0000 \pm 0.1494
Hg	0.0000 \pm 5.156	0.0000 \pm 0.0274	0.0000 \pm 0.0033
Pb	0.0000 \pm 11.81	0.0000 \pm 0.0628	0.0000 \pm 0.0076

Client: Bison
Report Date: 1/28/91

Project Number: 322/001
Date Received: 1/18/91

NEA ID: 91-Q233

Client ID: 09564

Site:

Sample Date:

Exposed Area: 406.0 cm²

Deposit Mass: 14900. +- 500. ug

Volume of Air Sampled: 1527. +- 152.7 m³

Suspended Particulates (): 9.758 +- 1.029 ug/m³

Element	ug/filter	percent	ug/m ³
Al	0.0000 +1042.	0.0000 +- 6.992	0.0000 +- 0.6822
P	0.0000 +- 20.22	0.0000 +- 0.1357	0.0000 +- 0.0132
S	273.1 +- 64.15	1.833 +- 0.4349	0.1788 +- 0.0457
Cl	0.0000 +- 28.30	0.0000 +- 0.1899	0.0000 +- 0.0185
K	435.6 +- 52.66	2.924 +- 0.3668	0.2853 +- 0.0448
Ca	1885. +-212.5	12.65 +- 1.488	1.235 +- 0.1861
Ti	58.71 +- 6.658	0.3940 +- 0.0466	0.0384 +- 0.0058
V	0.0000 +- 5.725	0.0000 +- 0.0384	0.0000 +- 0.0037
Cr	0.0000 +- 3.979	0.0000 +- 0.0267	0.0000 +- 0.0026
Mn	4.669 +- 3.207	0.0313 +- 0.0216	0.0031 +- 0.0021
Fe	106.7 +- 19.28	0.7161 +- 0.1316	0.0699 +- 0.0144
Ni	0.0000 +- 3.613	0.0000 +- 0.0243	0.0000 +- 0.0024
Cu	0.5278 +- 2.395	0.0035 +- 0.0161	0.0003 +- 0.0016
Zn	0.0000 +- 31.38	0.0000 +- 0.2106	0.0000 +- 0.0206
Ga	0.0000 +- 2.233	0.0000 +- 0.0150	0.0000 +- 0.0015
Ge	0.7714 +- 1.908	0.0052 +- 0.0128	0.0005 +- 0.0013
As	0.0000 +- 6.740	0.0000 +- 0.0452	0.0000 +- 0.0044
Se	0.0000 +- 2.395	0.0000 +- 0.0161	0.0000 +- 0.0016
Br	2.071 +- 2.761	0.0139 +- 0.0185	0.0014 +- 0.0018
Rb	1.827 +- 3.654	0.0123 +- 0.0245	0.0012 +- 0.0024
Sr	12.91 +- 4.060	0.0866 +- 0.0274	0.0085 +- 0.0028
Y	5.928 +- 4.304	0.0398 +- 0.0289	0.0039 +- 0.0028
Zr	42.51 +- 9.379	0.2853 +- 0.0637	0.0278 +- 0.0067
Mo	166.7 +- 16.56	1.119 +- 0.1173	0.1091 +- 0.0154
Pd	0.0000 +- 17.17	0.0000 +- 0.1153	0.0000 +- 0.0112
Ag	18.68 +- 22.65	0.1253 +- 0.1521	0.0122 +- 0.0149
Cd	59.11 +- 36.17	0.3967 +- 0.2431	0.0387 +- 0.0240
In	0.0000 +- 37.96	0.0000 +- 0.2548	0.0000 +- 0.0249
Sn	0.0000 +- 45.39	0.0000 +- 0.3046	0.0000 +- 0.0297
Sb	24.64 +- 54.61	0.1654 +- 0.3665	0.0161 +- 0.0358
Ba	0.0000 +-241.9	0.0000 +- 1.623	0.0000 +- 0.1584
La	0.0000 +-232.8	0.0000 +- 1.562	0.0000 +- 0.1524
Hg	0.0000 +- 5.319	0.0000 +- 0.0357	0.0000 +- 0.0035
Pb	0.0000 +- 12.26	0.0000 +- 0.0823	0.0000 +- 0.0080

Client: Bison
Report Date: 1/28/91

Project Number: 322/001
Date Received: 1/18/91

NEA ID: 91-Q234

Client ID: 09578

Site:

Sample Date:

Exposed Area: 406.0 cm²

Deposit Mass: 29200. +- 500. ug

Volume of Air Sampled: 1588. +- 158.8 m³

Suspended Particulates (): 18.39 +- 1.866 ug/m³

Element	ug/filter	percent	ug/m ³
Al	0.0000 +1067.	0.0000 +- 3.654	0.0000 +- 0.6719
P	0.0000 +- 20.50	0.0000 +- 0.0702	0.0000 +- 0.0129
S	326.6 +- 69.14	1.119 +- 0.2376	0.2057 +- 0.0482
Cl	0.0000 +- 30.77	0.0000 +- 0.1054	0.0000 +- 0.0194
K	799.0 +- 92.77	2.736 +- 0.3211	0.5032 +- 0.0771
Ca	2257. +-254.0	7.728 +- 0.8798	1.421 +- 0.2140
Ti	91.51 +- 8.079	0.3134 +- 0.0282	0.0576 +- 0.0077
V	4.507 +- 5.765	0.0154 +- 0.0197	0.0028 +- 0.0036
Cr	0.0000 +- 4.304	0.0000 +- 0.0147	0.0000 +- 0.0027
Mn	17.78 +- 3.857	0.0609 +- 0.0132	0.0112 +- 0.0027
Fe	808.8 +- 52.86	2.770 +- 0.1871	0.5093 +- 0.0608
Ni	0.0000 +- 3.613	0.0000 +- 0.0124	0.0000 +- 0.0023
Cu	8.851 +- 2.517	0.0303 +- 0.0086	0.0056 +- 0.0017
Zn	0.0000 +- 31.79	0.0000 +- 0.1089	0.0000 +- 0.0200
Ga	0.0000 +- 2.233	0.0000 +- 0.0076	0.0000 +- 0.0014
Ge	1.096 +- 1.989	0.0038 +- 0.0068	0.0007 +- 0.0013
As	2.720 +- 6.699	0.0093 +- 0.0229	0.0017 +- 0.0042
Se	0.0000 +- 2.395	0.0000 +- 0.0082	0.0000 +- 0.0015
Br	8.039 +- 2.801	0.0275 +- 0.0096	0.0051 +- 0.0018
Rb	4.831 +- 3.695	0.0165 +- 0.0127	0.0030 +- 0.0023
Sr	15.18 +- 4.101	0.0520 +- 0.0141	0.0096 +- 0.0028
Y	6.780 +- 4.344	0.0232 +- 0.0149	0.0043 +- 0.0028
Zr	38.04 +- 9.906	0.1303 +- 0.0340	0.0240 +- 0.0067
Mo	162.3 +- 16.65	0.5559 +- 0.0578	0.1022 +- 0.0146
Pd	0.0000 +- 17.70	0.0000 +- 0.0606	0.0000 +- 0.0111
Ag	0.0000 +- 23.79	0.0000 +- 0.0815	0.0000 +- 0.0150
Cd	0.0000 +- 36.58	0.0000 +- 0.1253	0.0000 +- 0.0230
In	0.0000 +- 37.96	0.0000 +- 0.1300	0.0000 +- 0.0239
Sn	39.02 +- 46.20	0.1336 +- 0.1582	0.0246 +- 0.0292
Sb	89.81 +- 55.66	0.3076 +- 0.1907	0.0566 +- 0.0355
Ba	15.79 +-244.0	0.0541 +- 0.8355	0.0099 +- 0.1536
La	381.6 +-230.9	1.307 +- 0.7909	0.2403 +- 0.1473
Hg	0.0000 +- 5.400	0.0000 +- 0.0185	0.0000 +- 0.0034
Pb	6.577 +- 12.14	0.0225 +- 0.0416	0.0041 +- 0.0077

